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CIVIL ENGINEERING

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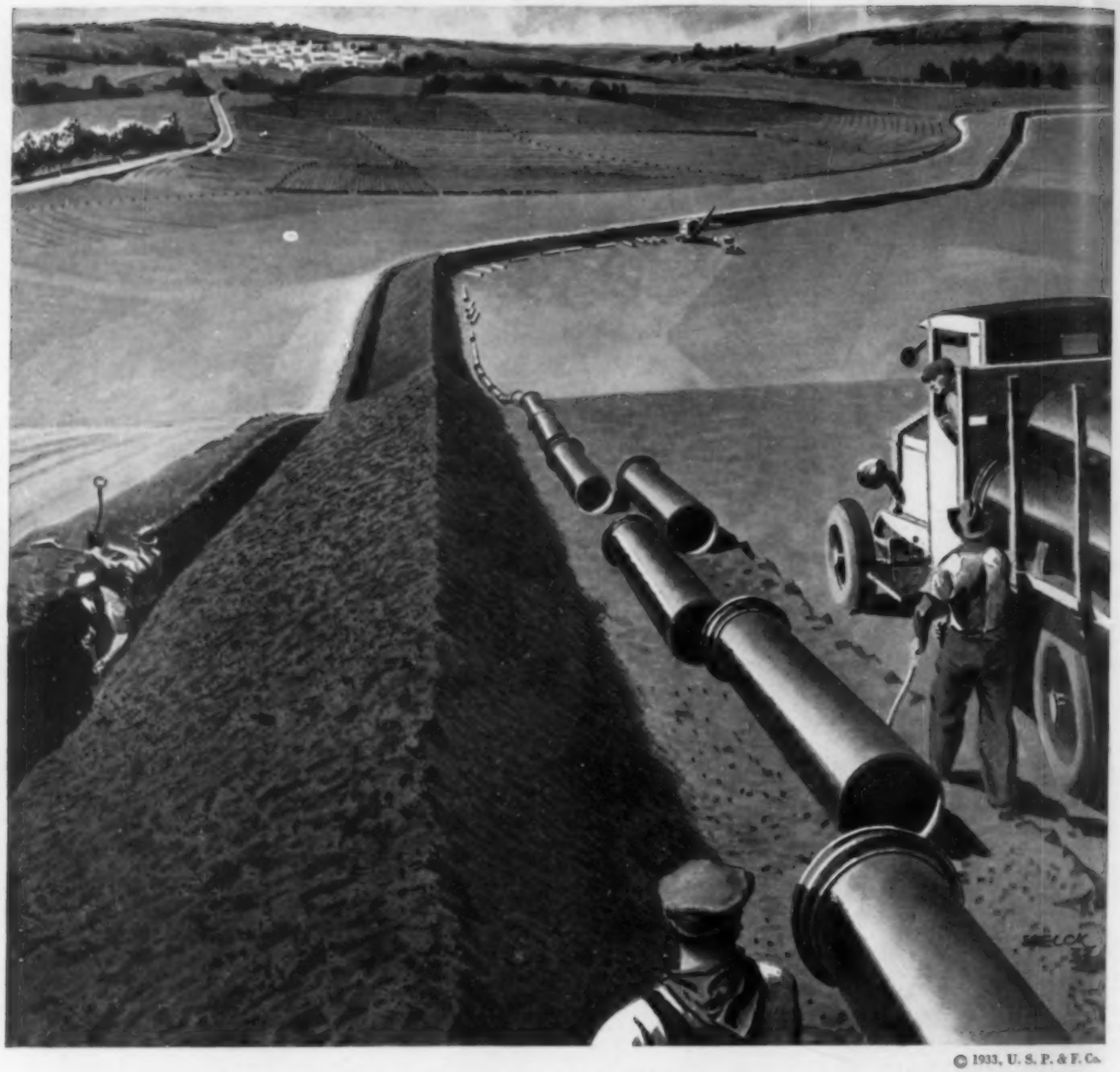
DUNES HIGHWAY (U.S. 31) BETWEEN BENTON HARBOR AND SOUTH HAVEN, MICH.
A Project of the Michigan State Highway Department, Built in 1931 Along the Shore of Lake Michigan

Volume 3 — Number 7

JULY 1933



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U. S. de LAVAUD PIPE

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JULY 1933

VOLUME 3

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NUMBER 7

The Little Belt Bridge, Jutland

Danish Engineers Solve a Difficult Foundation Problem

By ADOLF C. DAVIDS
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
and ANDREAS MORTENSEN
ENGINEERS OF BRIDGE DESIGN, DANISH STATE RAILWAYS, COPENHAGEN, DENMARK

WHEN the Little Belt Bridge is completed, probably in 1935, the Island of Fyen will be connected with the Jutland Peninsula for the first time. In order to span the intervening strait, called the Little Belt, a five-span truss bridge 2,706 ft long was decided upon. For the pier construction, caissons of a unique type were built on shore and sunk in more than 100 ft of water. The piers are founded 25 ft below the bottom on a thick, impervious clay stratum. The tallest pier has an over-all height of more than 220 ft. Erection of the main spans is now under way by cantilevering from each of the four river piers. The reinforced concrete approaches are of the arch-rib type, 100 ft high. An international committee appointed by the Danish Government to pass on the design for the bridge chose one proposed by engineers of the Danish State Railways, with certain modifications in caisson design, suggested by the successful bidder. In this article many of the problems confronting the designers of this $5,900,000 project are outlined, and the reasoning underlying the main design and construction features is given.

DANISH engineers are now in the process of completing the long needed Little Belt Bridge, which will tie Fyen, the next largest of the many Danish islands, to the Jutland Peninsula, on which one-third of the population of Denmark lives. The Little Belt, a narrow deep sound, the Great Belt, and Oresund form the only outlets from the Baltic Sea to Cattegat and the North Sea, as shown on the accompanying map. To interstate traffic these straits have always been a hindrance. But it was not until the Danish State Railway system was formed that the problem became acute because of increasing traffic and greater demands for speed.

As early as 1883 a bridge was considered for the Little Belt, which at its narrowest point is only 2,230 ft wide. Several tunnel, bridge, and dam projects were put forward from time to time, but it was not until 1920 when Slesvig (South Jutland) was reunited with Denmark that demands for a bridge across the Little Belt became so urgent that in 1927 the Danish Parliament was led to sanction the construction of a combined railroad and highway bridge.

Preliminary investigations were then undertaken to determine the location of the proposed bridge, its clear height, and traffic capacity. These were confined to the narrow part of the Little Belt, the Snaevringen, where two alignments were studied in detail. Here surveys, soundings, test borings, and pile loadings were made, together with traffic counts and observations on depth of water, movement of the current, and ice formation. By comparing the results of the new surveys and soundings with the corresponding data secured in 1883 it was found that very little change had taken place in this interval, as far as shore location and depth of water were concerned.

The borings indicated that tertiary clay, the so-called Little Belt clay, occurred everywhere below elevation −40 ft (Fig. 1). The layer is probably at least 300 ft thick and rests directly on chalk. In the strait itself the upper layers, 6 to 8 ft thick, are mixed with sand and stone, and at the shores the clay is covered by thick layers of tertiary mica clay topped by glacial formations. The Little Belt clay, on which the main piers rest, is a rich blue-green, homogeneous material with a variable content of chalk (about 15 per cent on the average) and an almost constant water content of 32 per cent. A

physical analysis of samples disclosed that the clay consists of extremely fine grains. By centrifugalization in Atterberg glasses with aqua ammonia and brushing, it was found that 81 per cent of the grains are smaller than 0.0008 in. and only 2 per cent are larger than 0.008 in. Tests for capillarity and permeability showed that the water content was homogeneous throughout. In consistency this material corresponds closely to London clay, although the grains of the former are much finer. An idea of its carrying capacity was obtained by imprint tests with 60-deg cones. The index number was in proportion to the load that would cause an imprint $^3/_8$ in. deep in a sample with normal water content.

Although the Little Belt clay has never before been employed as subsoil for a foundation, investigations indicated that it had a satisfactory carrying capacity, allowing for a certain rather slow settlement of the piers, as must be done in the case of all plastic clays. Borings and test piles on land showed that the carrying capacity of the soil was excellent at a depth of a few feet. The variation in the tides under ordinary conditions is only about 1 ft. Observed extreme high- and low-water levels were +5 ft and −5 ft 4 in., respectively. The currents in the strait depend on tidal variations, wind conditions, and the run-off from the watershed of the Baltic Sea. The most rapid current measured at the surface was found to be 11 ft per sec. Ice conditions were favorable, since the strait seldom freezes over and accumulations of ice are rare. Floating ice in large floes and packed ice are present occasionally. Frost occurs on the average of 85 days in the year.

As a result of the preliminary investigation, the adopted alignment was preferred because it had better foundation conditions; smaller depths of water at the site of the two middle piers—about 130 ft for a bridge with four piers; greater cross section, allowing correspondingly lower velocity of water; better conditions for navigation, with straight approaches on both sides of the bridge; and because the sea at that point is more quiet. The vertical clearance under the bridge was fixed at 108 ft, since the traffic investigation showed that this height would provide sufficient headroom for $99^1/_2$ per cent of the 12,000 ships yearly passing the site.

The arrangement of the cross section of the bridge (Fig. 3) called for a double-track railroad, since the three lines leading to it were double tracked. It was planned to give the roadway a width of 18 ft 5 in., which was ample since in 1928 the yearly traffic across the Little Belt by existing ferries was only 100,000 cars. (Today it is about 200,000.) For other traffic a sidewalk 8 ft 3 in. wide, with a special bicycle path, was planned.

The design specifications prepared by the State Railways differ somewhat from American practice. The trusses (Fig. 1) are designed for the train load shown in Fig. 2. In selecting this load due regard was paid to the possibility of future electrification. A uniformly distributed load of 102 lb per sq ft was used for the roadway and sidewalk. The impact or dynamic increment, I, to be added to the static action of the live load was calculated by the formula:

$$I = \left(\frac{1}{1 + L\left(\frac{n+1}{720}\right)}\right)\left(\frac{S_l^2}{S_l + S_d}\right)$$

in which n equals number of loaded lanes on railroad or highway; L, loaded length of influence line in feet; S_d, the action produced by dead load; and S_l, the static action produced by live load.

In the formula, S_l and S_d are to be taken in consistent units. No claim of absolute correctness is made for this formula, but it satisfies the main requirements: that I should decrease with (1) increased length of loading; (2) increased number of lanes; (3) an increase in the value of S_d; and (4) a decrease in the value of $\frac{S_l}{S_l + S_d}$.

The allowable stresses in tension or bending for steel having an ultimate tensile strength of 77,000 lb per sq in. and a yield-point strength of 51,000 lb per sq in., for main trusses and floor members, are: (1) for dead load plus live load plus impact, 27,000 lb per sq in; and (2) for dead load plus live load plus impact plus all extra loadings, 32,000 lb per sq in. For the wind-bracing, sway-bracing, and braking-truss members, the allowable stress for wind or temperature or braking, is 23,500 lb per sq in. The struts are designed according to A. Ostenfeld's formula based on the Johnson parabola, or for $\frac{l}{r} > 100$, in the Euler formula.

There were not enough data available about the magnitude of the greatest possible pressure from current, ice, or ships colliding with the pier. Therefore for the design of the main piers it was necessary to provide against certain types of loading dangerous to the stability of the pier. For instance there is the possibility of an ice accumulation that cannot pass the bridge extending from shore to shore. The depth of such an accumulation below water would decrease the cross section and cause a rise in head in front of the ice barrier. The piers were designed to resist the forces due to an ice accumulation 23 ft thick, or the impact of a 6,000-ton boat traveling at a speed of 13 ft per sec.

The maximum allowable pressure on the clay was fixed at 78 lb per sq in. in addition to the normal pressure

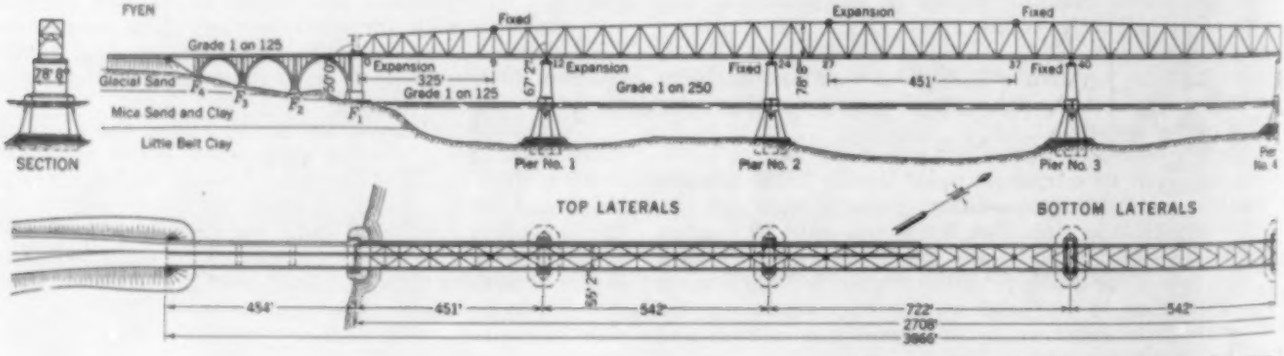
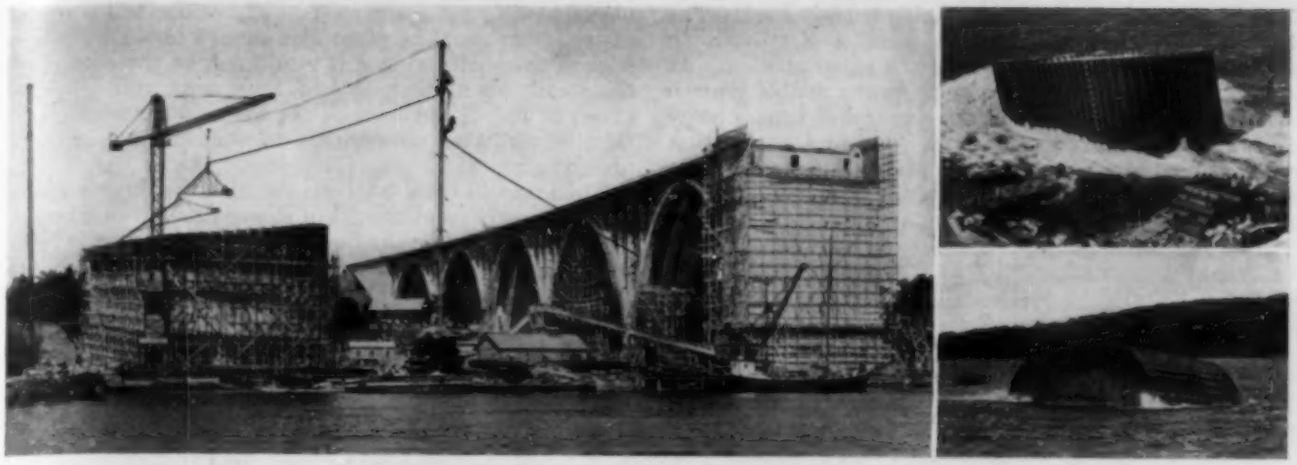


FIG. 1. PLAN AND PROFILE OF THE ADOPTED
The Little Belt Bridge, Between the Island of Fyen



Pier Caisson Erected Upside Down on Shore—Jutland Approach Structure at Right

Above: Launching the Caisson
Below: Turning It in the Water

CONSTRUCTION AND LAUNCHING OF A CAISSON

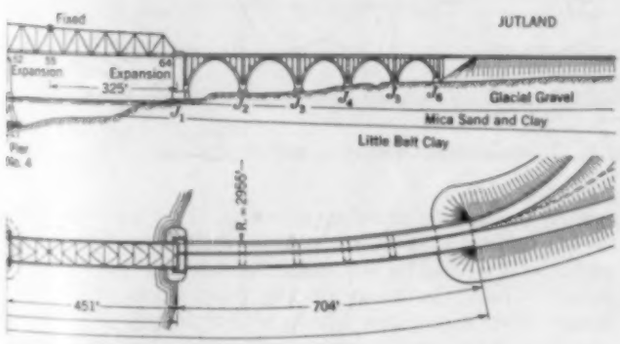
of water plus earth. For the piers on land, which rest on tertiary or glacial clay, an increase in pressure of 43 lb per sq in. was allowed.

Up to a height of 50 or 60 ft, the approaches consist of earth fill and short spans. This height was found to be the economical limit. For the section from the fill abutment to the shore pier the following types of construction were considered: fixed reinforced concrete arches; simple spans of reinforced concrete girders; plain concrete arches; and plate girders on concrete piers, trestle towers, or steel columns. Plain concrete arches and fixed reinforced concrete arches were considered equally desirable as far as appearance was concerned, but the latter were about 20 per cent cheaper than the other types. Also, they were the most desirable from an esthetic standpoint, considering the design finally adopted for the superstructure. Fixed reinforced concrete arches were therefore chosen. A photograph shows the Jutland approach under construction.

Fixed arches with a great rise are not very sensitive to temperature variations, settlement, or angular movement of the piers. For instance, it was found that a settlement of $^3/_4$ in. at the piers and a rotation of 3.5 min at any support would not increase the stresses above those allowable.

The abutment at the end of the fill is a cellular box built as a monolith with the adjoining foundation for the arch. It has great stability, since the earth pressure and the arch reaction act in opposite directions.

The shore piers serve as a support for both the main girders and the outer approach arches. Because of possible erosion, the piers have deep foundations. Those on the Jutland side are supported on 200 reinforced concrete piles, which are all battered to give greater stability. On the Fyen side, where the shore slopes sharply down at a grade of 1 on 1.4 to a depth of 80 ft, the foundation was carried down in a dry pit enclosed between two ring shaped cofferdams of steel sheet piling. For esthetic reasons the upper part of the pier was made 26 ft wide.



DESIGN, PROPOSAL I
and the Jutland Peninsula

MAIN TRUSSES OF CANTILEVER TYPE

There were five main requirements for the design of the superstructure, as follows: (1) A vertical loading should cause a vertical reaction at the piers, and any settlement of the piers should not cause stresses in the truss system. (2) The vertical clearance should be 108 ft. (3) The structure must be easy to erect without the use of scaffolding supported by piles or temporary piers. (4) No piers could be placed in the middle 650 ft of the strait and there should not be more than four piers altogether. (5) The structure should harmonize with the low contours of the shores.

Several types were excluded immediately by these five requirements. The designs considered were two types of suspension bridges with two river piers and a number of continuous spans supported on four river piers. Estimates showed that the types with three spans were from 25 to 50 per cent more expensive than those with five spans. After further study two cantilever types, known as Proposals I and II, with a nearly straight top-chord contour were selected as conforming best to the requirements and as being technically, economically, and esthetically satisfactory. Bids were invited on these two types, which were alike except at the piers.

In Proposal II the piers extended only slightly above the water level, while in Proposal I they extended nearly to the bottom of the truss, as shown in Fig. 1. The main trusses have fixed bearings at the two middle piers; other bearings are of the roller type. In this statically determinate design a clear distribution of loading is obtained. In the center span there are one fixed and one expansion hinge. All the hinges in the outer spans are fixed. At the expansion hinge the strut is hidden in a tension member. This type was preferred to eye-bars since the appearance is better and the amount of friction smaller. The design of the fixed hinge is similar to that of the expansion hinge except that the pendulum strut is shorter.

The hinge in the lower wind-bracing truss is fixed. The bottom wind-bracing members form a K-truss with hinges corresponding to those in the other trusses. At the top, the wind-bracing members form a double Warren truss and all hinges are of the expansion type. Sway bracing is placed over the main piers and at the first vertical member from the shore piers.

The specifications do not allow the punching of holes.

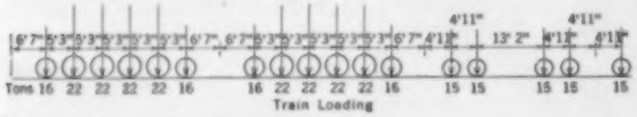


FIG. 2. TRAIN LOADING USED IN THE ADOPTED DESIGN

Generally holes are drilled to full size while the pieces are held firmly together in the right position. If the holes are drilled before assembly they must be reamed $^3/_{16}$ in. when assembled. All the main members must have one through web plate.

Only such erection methods were considered as would avoid the placing of scaffolding in the strait. Furthermore, it was required that the erection method should permit the superstructure and substructure to be built by different contractors.

In asking for bids, two erection methods were proposed. According to the first, the anchor spans would be floated out in a low position—at an elevation of about +30—and placed on the piers, which previously had been built to that height. As the pier construction proceeded the anchor spans would be jacked up until the final height was reached. The rest of the erection would be done by the cantilever method. According to the second, or cantilever method, the two panels on each side of the piers would be supported on steel scaffolding attached to the piers themselves, and steel erection would proceed to closure by the cantilever method.

The foundation of the main piers at elevation −120, in 100 ft of water, presented a very difficult problem. It was necessary to choose a method that would permit a direct examination of the bottom so that test loadings could be made; one that would allow for increases in the depth of the foundation, if this was found necessary during construction; and one that would avoid pouring of concrete under water as far as possible. It appeared that the use of caissons of reinforced concrete would economically combine stability and a large area on the bottom with relatively little weight of pier and a small decrease in the cross section of the strait. The caissons were to be built in a dry dock or on a slipway, launched, floated to a suitable place, ballasted until they stood on the bottom, built higher, and moved out to deeper water. These processes would have to be repeated until the necessary height for final placement had been attained.

In lowering the caisson to the bottom three methods were considered: first, the pneumatic method, using a working chamber 7 ft high and leveling the bottom either by excavation or by depositing a layer of small stones, which latter method would also protect the bottom against erosion; second, excavation to the full depth with grab-buckets before the caisson was placed; and third, excavation through open shafts in the caisson by employing rotating drills and jetting. In order that the caisson might be guided vertically the shafts would be placed along its circumference. The ceiling of the working chamber could be placed far enough above the lower edge of the shafts so that it would rest on the bottom of the strait when the pier had been sunk sufficiently—about 25 ft. Excavation of the working chamber could then be undertaken—perhaps without the use of compressed air.

The first and third methods satisfied the three requirements already mentioned, but it was decided to ask that the bids be based on the first—the well known pneumatic method. Also, the contractors were requested to investigate the practicability of applying the third method, in which the characteristics of the Little Belt clay—homogeneity and low permeability—could be used, and the difficulties and expense of work under compressed air avoided or reduced.

Bids were invited October 1, 1928, according to the plans, descriptions, and conditions for Proposals I and II designed by the State Railways. The bidders could include either all the work or one or more of the parts—approaches, superstructure, and piers. The contractor could also make alternative proposals, provided they did not change the location of the bridge or increase the number of the piers. All the proposals were to be judged by an international committee appointed by the Danish Government.

Altogether 22 bids were received, 4 of which included the whole project. Nine bids were received on the superstructure, and all of them showed that the total cost for Proposal II was about the same as that for Proposal I. Several of the firms submitted bids on alternative designs, two of which came from a United States company. The lowest bid for Proposals I and II came from a group of German firms, who proposed to use the State Railways' method of erection by cantilevering from each pier.

For the substructure 7 bids were received on the State Railways' proposal and 4 alternatives. Two firms, Monberg and Thorsen, of Copenhagen, and Grün and Bilfinger, of Germany, submitted a joint bid on a method resembling in principle one of those suggested by the State Railways, calling for excavation through open pipes. The design of the caisson, as well as the arrangement of the excavation was to be accomplished by placing around the lower part of the caisson, and joined with it, a wall of vertical riveted pipes and structural steel tied together and braced by steel trusses.

This cofferdam wall consisting of pipes was to be carried down into the clay about 23 ft by excavation in the pipes with special rotating drills combined with water jetting, and by the weight of the pier and by water ballast. In order to guide the excavation drills, temporary extension pipes would be employed. When the pier had reached the proposed depth, the permanent pipes were to be filled with concrete poured under water. Thereafter it was planned to pump the working chamber

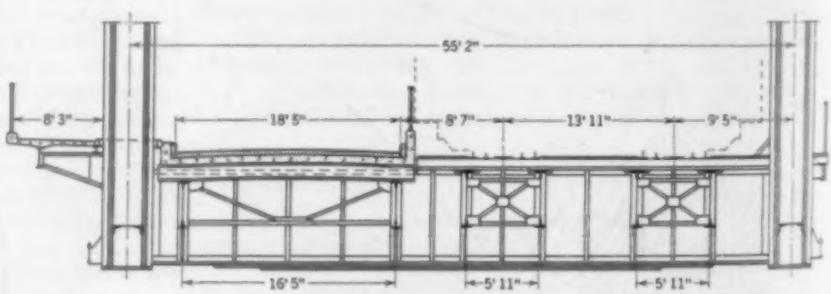


FIG. 3. CROSS SECTION THROUGH THE ROADWAY

dry and pour the rest of the concrete without the use of compressed air. It was intended that the steel structure of the caisson should be erected from scaffolding while the caisson was resting on a steel platform that could be lowered until the caisson was afloat.

CONTRACT AND CONSTRUCTION WORK

In accordance with the recommendations of the international committee, the contract was awarded to a group of associated firms consisting of Monberg and Thorsen, of Copenhagen; Grün and Bilfinger, of Mannheim; Friederich Krupp, Friederich-Alfred-Hütte, of Rheinhaus; and Louis Eilers, of Hannover.

The bids had shown that Proposal II, with low concrete piers and steel supports, was but little cheaper than Proposal I. Since Proposal I was esthetically the better design, the committee recommended it for adoption.

TABLE I. PROGRESS OF PIER CONSTRUCTION

CONSTRUCTION STEPS	PIER No. 1	PIER No. 2	PIER No. 3	PIER No. 4
Construction started	9-10-31	3- 9-32	4-27-31	7- 4-30
Launching	3- 8-32	7-19-32	9- 4-31	4-27-31
Placing	7-16-32	3-20-33	2-13-32	9-24-31
Excavation started	12-10-32	.....	6-20-32	11-24-31
Pipes concreted	2-18-33	.....	9-20-32	2-27-32
Chamber concreted	4- 3-33	.....	11-21-32	5-27-32
Finished	.....	.....	4-20-33	11-11-32

The substructure was to be constructed according to the proposal of Monberg and Thorsen, with certain modifications, so that the ceiling of the working chamber and the supporting girders would form a monolithic reinforced concrete structure. Therefore the State Railways recommended that the caissons should be built on slipways in an inverted position. The reason for this was that, since the pipes were of unequal length to fit the shape of the bottom at the site, the draft of the caissons would be less in the inverted position.

Field work was started in the spring of 1929 by building shops and slipways close to the site of the Jutland approach spans, so that the concrete for these and the caissons could be brought in from a central mixing plant. The approach arches on both sides were finished in February 1933. The steps in the launching of the caissons are shown in some of the accompanying photographs, and the construction of these unique foundations may be seen in Fig. 4. The rate of progress is shown in Table I.

Now that three of the four piers are practically completed, the method has already proved its excellence. A few additional details may be of interest. The launching took place from a slipway curved downward—thereby reducing its length. The turning of a caisson was a most interesting operation, and was carried out according to schedule. The next stage, placing of the caisson in its final position, caused some difficulties, since a sudden increase in the speed of the current carried the caisson away several times just as it had been placed. The piers were located in their final position by triangulation and direct measurement with copper wire.

Each pier had a working platform on which were mounted two swing cranes and drill towers, plants for compressed air, and water pumps. The equipment for excavating the inside of the pipes proved very satisfactory. A few large boulders, from the bottom of the strait, were found deep in the pipes and had to be removed. A diver could just get into the pipes, which were 3 ft in diameter. Pouring of the concrete in the pipes was done under water, since it was considered dangerous to empty each pipe for fear that the homogeneity of the clay might be destroyed if water broke through at the bottom. Special steel boxes with collapsible bottoms holding 1 cu yd were constructed for this purpose, and by means of them an average of 120 cu yd of concrete was placed daily.

The excavation and concreting of the working chamber at elevation −115 ft was carried out without the use of compressed air, and no pumping was necessary. The cellular reinforced concrete construction proved to be very practical, since it was easy to straighten up the pier when it showed a tendency to sink unevenly. This was accomplished by ballasting one side and placing jacks between the ceiling of the working chamber and the sea bottom. Each of the finished piers weighs 60,000 tons and has a bottom area of 10,000 sq ft.

Erection of the 13,000-ton steel superstructure commenced this spring, and it is expected that the bridge will be open for traffic in 1935. The cost of the whole structure will be 22,000,000 kroner ($5,900,000), of which two-thirds will be paid by the Danish State Railways and one-third from a state tax on gasoline. Passage across the bridge will probably be free. The Danish State Railways is the builder; H. Flensborg, Chief of the Department of Way and Works, has been in charge of design; and Prof. A. Engelund is designing engineer.

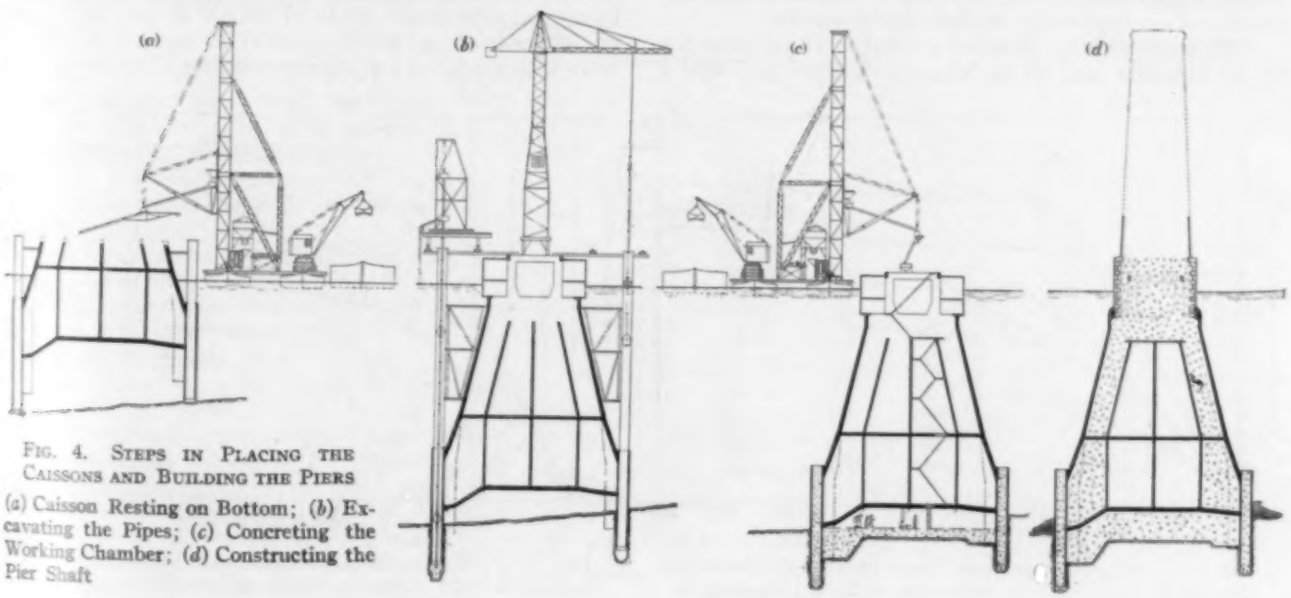


FIG. 4. STEPS IN PLACING THE CAISSONS AND BUILDING THE PIERS

(*a*) Caisson Resting on Bottom; (*b*) Excavating the Pipes; (*c*) Concreting the Working Chamber; (*d*) Constructing the Pier Shaft

Tests of Reinforced Concrete Columns

A High Percentage of Longitudinal Reinforcement Adds Its Full Yield-Point Strength

By INGE LYSE

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LONGITUDINAL reinforcement up to only 6 per cent was used in the concrete column investigation of Committee 105 of the American Concrete Institute, now practically completed. Hence the importance of the series of tests undertaken at the Fritz Engineering Laboratory of Lehigh University, here described by Professor Lyse. In these tests, concrete columns containing as much as 17½ per cent of longitudinal reinforcement were used. The results corroborate those of the previous investigation, that such reinforcement adds its full yield-point strength to the column. Some of the columns tested were reinforced with high yield point steel and some with welded reinforcement. Six conclusions of interest to designers have been drawn from these tests by Professor Lyse, and are listed at the end of the article.

IN the reinforced concrete column investigation sponsored by the American Concrete Institute and aided financially by the Society, certain relationships were established between the properties of the materials and the strength of the column. The three progress reports of the institute's Committee 105 appeared in the *Proceedings* of the institute for 1930 (Vol. 26), 1931 (Vol. 27), and 1932 (Vol. 28), and the tentative final report in its *Journal* for February 1933 (Vol. 4, No. 6). In this investigation the ultimate strength of the column was found to be made up of the strength of the concrete (the column strength being equal to about 85 per cent of the cylinder strength) and the yield-point strength of the longitudinal steel. For columns having spiral reinforcement that produced strength in excess of that of the fireproofing shell, the strength of the column was increased by the spiral.

NEED FOR THESE TESTS

Since the longitudinal reinforcement in all the columns included in the investigation was only 6 per cent or less, it seemed important that tests should be made on columns with greater percentages of such reinforcement. Consequently the Fritz Engineering Laboratory of Lehigh University carried out the investigation here described on columns having as much as 17½ per cent of longitudinal reinforcement. Tests were also made on columns containing a very high grade of steel as reinforcement and on some with welded reinforcement.

This series of tests included a total of 42 columns 8¼ in. in diameter and 60 in. long, as outlined in Table I. Two concretes, with a design strength of 2,000 and 4,000 lb per sq in., were used. Plain columns were made with each grade of concrete. For 2 per cent of spiral reinforcement the percentages of longitudinal reinforcement were 1½, 6, 10½, 14, and 17½. In columns with longitudinal reinforcement of 14 per cent, spiral reinforcement of zero, 1⅛, and 2 per cent was used.

The bars in the columns having 1½ and 6 per cent of longitudinal reinforcement were of the same stock as those used in the American Concrete Institute's column investigation. The yield-point stress was 47,800 lb per sq in. for the 1½ per cent of longitudinal reinforcement and 44,900 lb per sq in. for the 6 per cent of longitudinal reinforcement. The bars in the columns having 10½, 14, and 17½ per cent of longitudinal reinforcement were 1½ in. in diameter and had an average yield-point stress of 36,900 lb per sq in. The spirals came from the same stock as those that were used in the American Concrete Institute's investigation.

No yield point could be determined from the tests of the steel used for spiral reinforcement. The ultimate strength was 82,200 lb per sq in. for the 1⅛ per cent spiral and 74,560 lb per sq in. for the 2 per cent spiral.

HIGH YIELD POINT STEEL ALSO USED

Additional tests were made on columns in which the 6 per cent of longitudinal reinforcement consisted of bars having a yield-point stress of 94,500 lb per sq in. and an ultimate strength of 132,500 lb per sq in. Tests were also made on columns containing 17½ per cent of

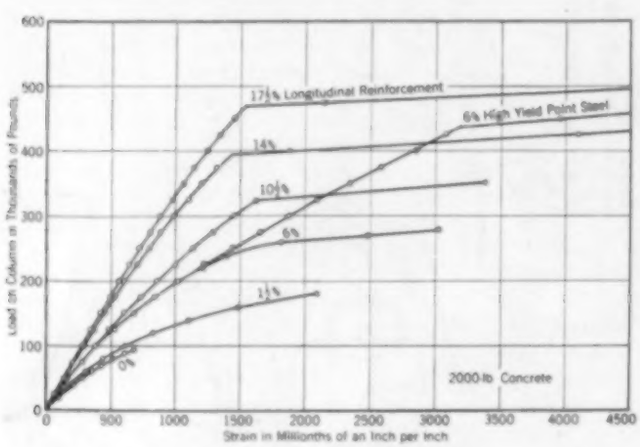


FIG. 1. LOAD-DEFORMATION DIAGRAM FOR COLUMNS OF CONCRETE WITH A DESIGN STRENGTH OF 2,000 LB PER SQ IN.

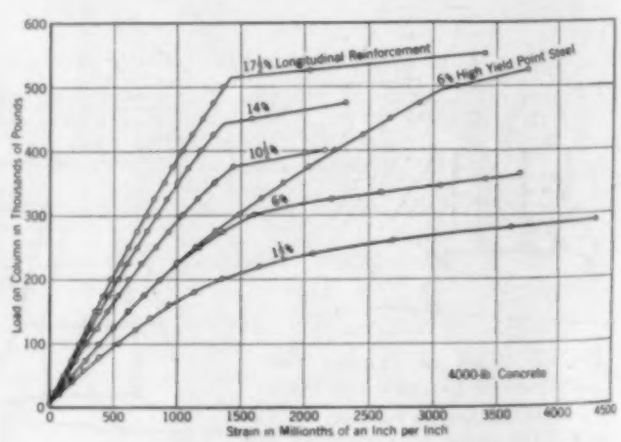


FIG. 2. LOAD-DEFORMATION DIAGRAM FOR COLUMNS OF CONCRETE WITH A DESIGN STRENGTH OF 4,000 LB PER SQ IN.

longitudinal reinforcement, where each bar was cut in half and welded together electrically before being placed in the column.

TABLE I. PROGRAM OF TESTS ON REINFORCED CONCRETE COLUMNS

$8\frac{1}{2}$ In. in Diameter and 60 In. Long

PERCENTAGE OF REINFORCEMENT		DESIGN STRENGTH OF CONCRETES Lb per Sq In.		NUMBER OF EACH KIND	TOTAL NUMBER OF COLUMNS
Longitudinal	Spiral				
0	0	2,000	4,000	3	6
$1\frac{1}{2}$	2	2,000	4,000	2	4
6	2	2,000	4,000	2	4
6*	2	2,000	4,000	2	4
$10\frac{1}{2}$	2	2,000	4,000	2	4
14	0	2,000	4,000	2	4
14	$1\frac{1}{4}$	2,000	4,000	2	4
14	2	2,000	4,000	2	4
$17\frac{1}{2}$	2	2,000	4,000	2	4
$17\frac{1}{2}$†	2	2,000	4,000	2	4
			Total. . .		42

* High yield-point steel.
† Welded reinforcing bars.

The columns were made during October and November 1932, and tested at the age of 28 days. The cement and other materials for the concrete, and the methods of making, curing, and testing were the same as those used in the American Concrete Institute's investigation and described in Research Circulars Nos. 64 and 81 of Lehigh University. A photograph shows the reinforcing units for 14 per cent of longitudinal, and no spiral, reinforcement.

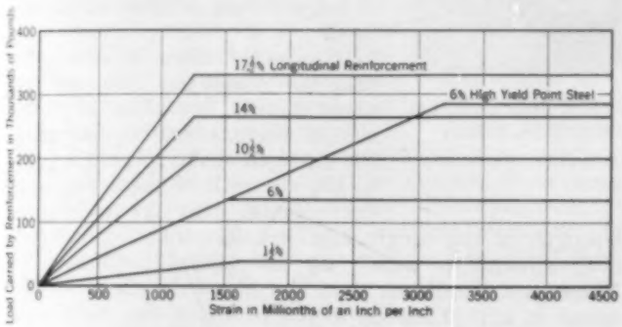


FIG. 3. LOAD-DEFORMATION DIAGRAM FOR LONGITUDINAL STEEL

RESULTS DISCUSSED

Both concrete mixes had the same water content per cubic yard of concrete. The average slumps for the concrete were 6.3 and 7.6, respectively, for the 2,000 and 4,000 lb per sq in. mixes. From the summary of results given in Table II it is noted that the strengths of both concrete mixes remained fairly constant for all the columns. The results for companion columns were quite uniform throughout.

In Figs. 1 and 2 are shown the load-deformation curves for columns having design strengths of concrete of 2,000 and 4,000 lb per sq in. In Fig. 3 the relation between the deformation of the longitudinal reinforcement and the load carried by it is shown for the various percentages used. A comparison of Fig. 3 with Figs. 1 and 2 discloses a striking similarity. The distances between the curves for the various percentages of reinforcement are very nearly the same in the three figures, indicating that the steel is giving its full stress value to the column, at any strain, regardless of the amount or grade of the steel. Except for the columns having only $1\frac{1}{2}$ and 6 per cent of longitudinal reinforcement, a sharp break in the deformation curves at strains corresponding approximately to the yield-point strain of the reinforcement indicates the yield point of the columns. The greater the percentages of longitudinal reinforcement, the sharper is the break in the deformation curves.

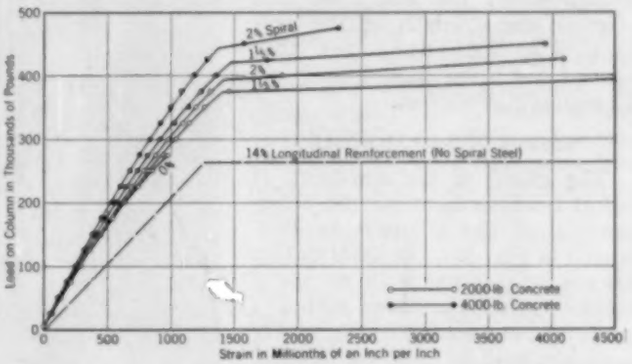


FIG. 4. EFFECT OF SPIRAL REINFORCEMENT ON DEFORMATION AND YIELD POINT
For the Two Design Strengths of Concrete

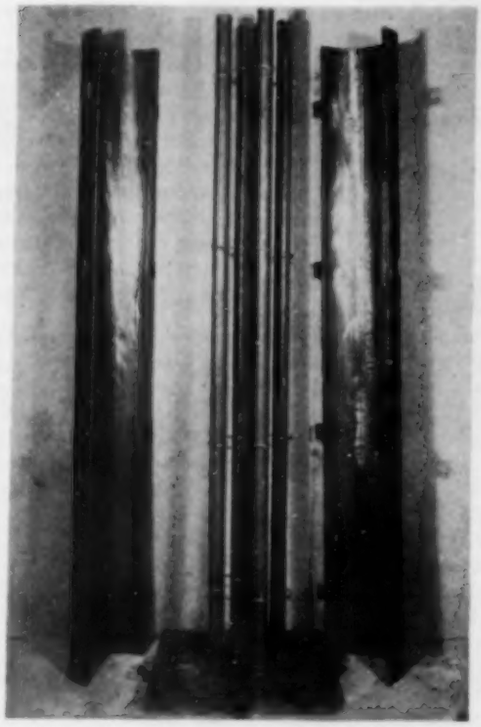
It is noted that the deformation curves for the columns containing the high yield-point steel showed a greater increase in load with increase in the strain beyond the yield point than did the curves for columns containing mild steel. This is evidently due to the fact that the high yield-point steel did not have a sharp yield point. The testing machine showed no drop of the lever at the yield point of this steel, so that it had to be determined from the stress-strain diagram. The strength results indicate that at maximum load the high yield-point steel sustained a load corresponding to 120 per cent of its yield-point strength. Attention is called to the fact that the total

TABLE II. RESULTS OF COLUMN TESTS SUMMARIZED

PERCENTAGE OF REINFORCEMENT		STRENGTH OF INDIVIDUAL COLUMNS, IN LB			AVERAGE STRENGTH OF COLUMNS, IN LB	AVERAGE CYLINDER STRENGTH Lb per Sq In.	EFFECTIVENESS OF CONCRETE	EFFECTIVENESS OF SPIRAL*
Longitudinal	Spiral							
0	0	115,300	119,500	116,800	117,200	2,350	0.93	..
0	0	207,500	207,400	230,000	215,000	4,020	1.00	..
14	0	347,000	363,500	....	355,200	2,390	0.91	..
14	0	401,600	416,800	....	409,200	3,780	0.91	..
14	$1\frac{1}{2}$	398,500	401,500	....	400,000	2,360	0.85†	1.87
14	$1\frac{1}{4}$	449,000	457,000	....	453,000	3,780	0.85	1.91
14	2	440,500	437,000	....	438,750	2,550	0.75	1.85
14	2	524,500	501,000	....	512,750	4,160	0.85	2.18
$1\frac{1}{2}$	2	231,000	234,000	....	232,500	2,740	0.85	1.78
$1\frac{1}{2}$	2	295,000	301,000	....	298,000	4,010	0.85	2.05
6	2	331,000	327,000	....	329,000	2,680	0.85	2.01
6	2	384,200	380,300	....	382,250	4,340	0.85	1.71
6§	2	532,000	508,000	....	520,000	2,830	0.85	1.74‡
6§	2	580,000	561,000	....	570,500	4,460	0.85	1.40‡
$10\frac{1}{2}$	2	379,000	375,000	....	377,000	2,820	0.85	1.62
$10\frac{1}{2}$	2	445,000	444,000	....	444,500	4,530	0.85	1.68
$17\frac{1}{2}$	2	512,000	519,000	....	515,500	2,630	0.85	2.11
$17\frac{1}{2}$	2	578,000	554,500	....	566,250	4,580	0.85	1.70
$17\frac{1}{2}$‖	2	495,000	508,500	....	501,750	2,640	0.85	1.80
$17\frac{1}{2}$‖	2	568,000	569,000	....	568,500	4,280	0.85	2.00

* Based on 44,000 lb per sq in. yield-point stress.
† Assumed.
‡ Based on a value of 120 per cent of the yield-point strength for the effectiveness of the longitudinal steel.
§ High yield-point strength.
‖ Welded bars.

deformation at the yield point of the column was more than twice as large for the high yield-point steel as for the ordinary reinforcing steel. Thus the amount of flow in a column may be doubled before the yield-point stress of the steel has been reached. Sponsors of design for effect of flow on stress in reinforcement should therefore welcome the introduction of the high yield-point steel. Furthermore, the effect of this steel on the strength of the column is so advantageous that special attention should be given to such reinforcement.



FORM AND REINFORCEMENT FOR TEST COLUMNS $8^1/_4$ IN. IN DIAMETER AND 60 IN. LONG
For 14 Per Cent of Longitudinal Reinforcement and No Spiral

EFFECT OF SPIRAL STEEL

The effect of the amount of spiral reinforcement on the deformation of the columns is illustrated in Fig. 4. The deformation curves for columns with no spiral reinforcement, and those with $1^1/_8$ per cent, are seen to very nearly coincide, both for concrete of 2,000 and 4,000 lb per sq in. The deformation curves for the columns having 2 per cent of spiral reinforcement, however, are somewhat steeper than those for the other columns. This is due partly to the difference in the strength of the concrete. As shown in Table II, the strength of the concrete used in the columns having 2 per cent of spiral reinforcement was about 10 per cent higher than that in the columns with no spiral reinforcement or $1^1/_8$ per cent.

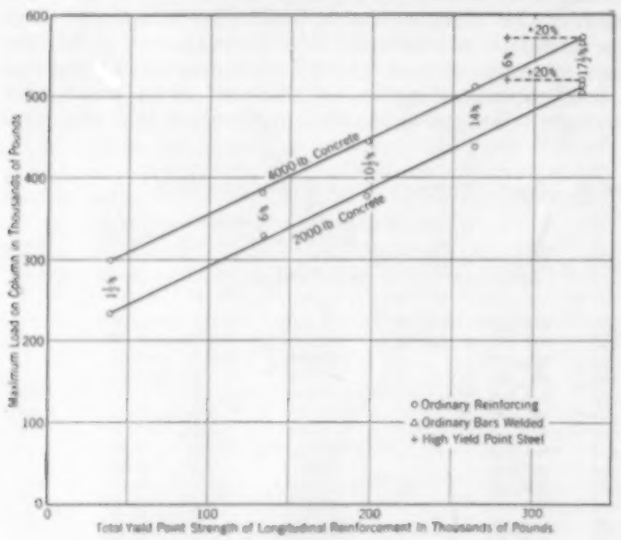

Maximum Load on Column in Thousands of Pounds
Total Yield Point Strength of Longitudinal Reinforcement in Thousands of Pounds
4000 lb Concrete
2000 lb Concrete
o Ordinary Reinforcing
Δ Ordinary Bars Welded
+ High Yield Point Steel

FIG. 5. EFFECT OF YIELD-POINT STRENGTH OF LONGITUDINAL REINFORCEMENT ON STRENGTH OF COLUMNS
For the Two Strengths of Concrete

When corrections are made for this difference in strength, it will be seen that the deformation curves, as well as the yield point of the columns, will very nearly coincide for the columns containing various amounts of spiral reinforcement.

In Table II, the strengths of all the columns are given. Selecting those with 2 per cent of spiral reinforcement, the maximum load on each column has been plotted against the yield-point strength of its longitudinal reinforcement, as shown in Fig. 5. This diagram proves conclusively that the longitudinal reinforcement adds its full yield-point strength to the column, regardless of amount, up to $17^1/_2$ per cent. The high yield-point steel is found to contribute to the strength of the column an amount of load corresponding to 120 per cent of the steel's yield-point strength. Furthermore, the parallelism of the curves in Fig. 5 shows that the grade of concrete has no effect on the strength added by the longitudinal reinforcement. These results are in harmony with those obtained in the American Concrete Institute's investigation, in which a maximum of 6 per cent of longitudinal reinforcement was used.

It may therefore be concluded that for reinforced concrete columns having less than $17^1/_2$ per cent of longitudinal reinforcement the strength of the column is equal to the strength of the concrete in the column, plus the yield-point strength of the longitudinal reinforcement, plus whatever amount is added by the spiral reinforcement. These tests indicate that the strength added by the spiral is approximately equal to twice the yield-point strength of the spiral less the amount of load carried by the protective shell outside the spiral.

SUMMARY OF CONCLUSIONS

The following conclusions have been drawn from the series of tests conducted at the Fritz Engineering Laboratory and here described:

1. The deformation curve for reinforced concrete columns having 10 per cent or more of longitudinal reinforcement showed a definite yield point. This yield point corresponded approximately to the yield point of the longitudinal reinforcement.
2. Columns containing high-grade steel showed a yield-point deformation more than twice as large as those containing ordinary reinforcing steel.
3. The longitudinal reinforcement, up to $17^1/_2$ per cent, added its full yield-point strength to the column. This was the largest amount of such reinforcement used in the investigation.
4. High yield-point steel added about 20 per cent more than its yield-point strength to the strength of the column.
5. The strength of tied columns was 85 per cent of the unit cylinder strength of the concrete, multiplied by the total area of concrete, plus the unit yield-point stress of the longitudinal reinforcement, multiplied by its area. The same would be true of columns with spiral reinforcement in which the spiral steel had a strength equal to, or less than, the strength of the protective shell.
6. For design purposes, the effectiveness ratio of spiral reinforcement may be considered as equal to 2.0.

Early Truss Bridges of Wood and Iron

Railroad Spans of the Eighties Marked by Many Peculiarities

By C. D. PURDON

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MANY handicaps confronted the bridge engineers of the early railroads—the limitations of the materials available, the status of the knowledge of design, and the rapidly increasing weight of locomotive and train loads. Most, if not all, of the original wood and iron railroad bridges in this country have now been replaced by heavier and more useful steel structures. This partial record of the examination of hundreds of those early spans, amplified by the author's extensive experience covering a period of sixty years, will be of interest to both younger and older members of the profession. To the former it will be an illuminating chapter in the development of the modern bridge; to the latter a scene from a well known drama, to be turned back to with pleasure.

DURING the decade beginning about 1890, a general movement toward the use of larger locomotives by American railroads began. Each railroad had its own typical engine, and all differed slightly in amount and distribution of load. The unit stresses allowed in bridge structures by the various roads also varied widely.

When changes in loadings caused a general investigation of existing structures, many of the older bridges were found to be obsolete. During this time I inspected, maintained, and replaced many old or light bridges, and saw and read of many peculiar and freak structures, both in this country and abroad. Among the older and more unusual types of bridges in use during the nineties were the all-wood Howe truss, particularly for highway spans; the wooden Howe truss with iron vertical members; the Cartter combination, of wood with an iron lower chord;

FIG. 1. A HOWE TRUSS WITH STRENGTHENING ARCH
In the "Cartter Combination" the Iron Bottom Chord Members Were Joined as Shown at Right and Covered with a Casting

the Burr truss; and the Howe truss strengthened by a wooden arch (Fig. 1), all of which may be considered obsolete if for no other reason than that a steel span can be built more cheaply. The truss with a wooden arch must have been the one described by "John Phoenix" when he said that he was much pleased with these bridges, as they were so strong they were pushing the back walls of the masonry abutments over.

The original Howe truss was an all-wood structure with its wooden verticals notched for the chords and leveled to form a seat for the diagonals. Iron was later substituted for wood in the tension members. In the modification of the Howe truss, as built by M. S. Cartter of St. Louis, the bottom chord was made of iron plates about ½ by 4 in. They were joined by turning back the ends of each plate, as shown in Fig. 2, butting the offsets together, and covering the joint with a casting.

At old Albuquerque, N.Mex., over the Rio Grande, there was a highway bridge of the Howe type supported on peculiar piers. Each pier consisted of two cast-iron piles, the cross section of each being shaped like a cross with 10-in. arms. These were driven into the sand in line with the trusses, which rested on a cast-iron shoe at the top of each pile.

In the Bollman truss, which had practically no lower chord, Fig. 2 (*a*), each floor beam was supported by bars extending to the tops of the pairs of end posts. These diagonal bars were so flat that they developed decided secondary stresses and were not economical. The last one in use, on the Baltimore and Ohio Railroad at Harper's Ferry, has now been replaced by a more modern structure.

A truss, Fig. 2 (*b*), designed by Albert Fink and named for him, may possibly have been a development of the Bollman truss. It was a great improvement. Another truss used a good deal was the Post truss. It had struts, or compression members, a half panel apart and ties, or tension members, one and one-half panels apart, as shown in Fig. 2 (*c*). The last bridge of this type in use was at Little Rock, Ark., over the Arkansas River. It carried a railway below and a highway above.

An old-style combination frequently used for short spans was the familiar "hog-chain," Fig. 2 (*d*), in which two or more wooden stringers were reinforced with iron rods and vertical needle beams. The Warren truss, shown in Fig. 2 (*e*), is another old type which was originally designed with equilateral panels, and in that form is still used for deck spans of comparatively short length. The Warren truss is still in general use, modified by adding vertical members at the panel points to take the floor-beam reactions and permit the use of longer panels.

The bridges with which I had personal experience were of various types and had various defects. Some of them were of unusual interest.

The late C. Shaler Smith, M. Am. Soc. C.E., designed

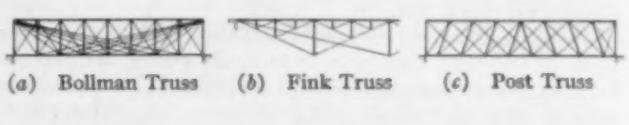


FIG. 2. TYPES OF TRUSSES NOW GENERALLY OUTMODED

many bridges in the Middle West. These were Pratt trusses, a type which still holds its place as a favorite. Mr. Smith used two eye-bars and two channels in the two end panels of the lower chord, the channels also providing stiffness for wind stress. Shop work was not as good in those days as now, and in many spans the eye-bars were rather loose. An attempt had been made in

some to correct this fault by heating the eye-bars and striking the end with a sledge, but it was anything but a success.

In some spans a square cut had been made in the floor beams to clear the chord pin. This generally started a crack and required field repair. The plans often consisted of a blueprint, not to any particular scale, showing a picture of a half span, on which were written all dimensions and distances for the truss, the stringers, and the floor beams, as well as the number of rivets and the stresses in the members.

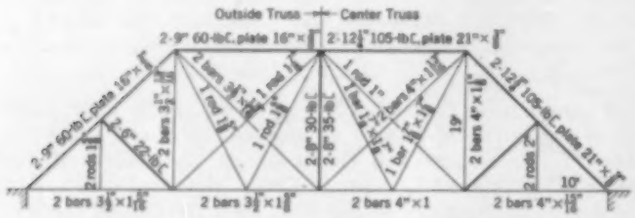


FIG. 3. A DOUBLE-TRACK IRON BRIDGE OVER THE OATKE RIVER, NEW YORK

An 80-Ft Span with Three Trusses on 15-Ft Centers, Built in 1882

The Whipple truss, shown in Fig. 2 (*f*), was also a favorite type, although it was generally used for longer spans. The principal objection to it was that the proportion of load carried by each system of triangles had to be assumed, or guessed at.

In taking down some old spans I found that thin eye-bars, about a half inch thick, had cut grooves in the pin making it difficult to drive the pin out. Occasionally the head of an eye-bar would fly off. The heads had been welded on instead of being formed by upsetting and boring.

OLD EXPANSION ROLLERS INADEQUATE

Expansion rollers seemed a neglected detail. On one large span, a 400-ft Whipple truss, the rollers were only 2 in. in diameter. They had flattened slightly, broken their side bars, and skewed out of position. These spans rested on granite pedestals 24 in. high, set on the coping of the piers. The pedestals were taken out by raising one corner of the span a few inches, since the width of the spans was sufficient to allow it, and 24-in. segmental rollers were substituted.

An old span, over 200 ft long, on a branch line, had vertical posts consisting of four angles and a web, which were not connected on the chord pins but simply butted against the top chord, and the web merely rested on the lower chord pin.

Two small bowstring spans had the top chord, or bow, built of two 6-in. channels, bent to the curve, the top and bottom plates making a closed section. There were two sets of vertical rods dividing the span into three panels of about 12 ft each. Diagonal rods 1 in. in diameter acted as braces. The lower chord, or the string of the bow, consisted of two bars about 3 by $^1/_2$ in., each drawn down to 1 in. in diameter at the ends, threaded, passed through holes in the bow, and held by nuts. A few pieces of 12 by 12-in. timber formed the ties, which were laid directly on the lower chord.

Three spans in north Texas, about 150 ft long, had a peculiar arrangement at the hip vertical U1 L1, which, instead of being connected on the pin U1 at the top of the end post, was on a pin of its own a few inches from the pin at U1.

A continuous bridge consisting of two center spans 75 ft long, with a 25-ft span at each end, over an arroyo in New Mexico, was jammed tight against the back walls of the abutments. The rivets had worked into the masonry and held the ends of the bridge up off their seats so that the rollers could be taken out, even when a train was crossing.

TROUBLES WITH A MOVABLE BRIDGE

At Fort Madison the coned rollers of the turntable of a 400-ft draw span were connected by rods to a circular center plate about 6 ft in diameter. The span had a highway floor on each side, outside the trusses and at track level. The turning engine and its fuel were on the upstream side, thus weighting the span unevenly. The span was always turned in the same way so that the rails would fit those on the fixed span. While the span was turning, the combination of unequal loading and the type of connection at the center plate made the coned rollers hang back instead of rolling in a true circle. After a time this action caused the span to shear off the bolts at the center and move bodily upstream until the gear wheels were jammed so tight against the rack circle that it was almost impossible to turn the span. Some study convinced us that the method of connecting the roller rods to the center plate was the cause of the trouble. To correct this, one-half the lower circle on which the rollers ran was oiled and the other half sanded. Then by turning the span back and forth, it was gradually brought back into place. The sheared bolts at the center were then replaced with larger ones.

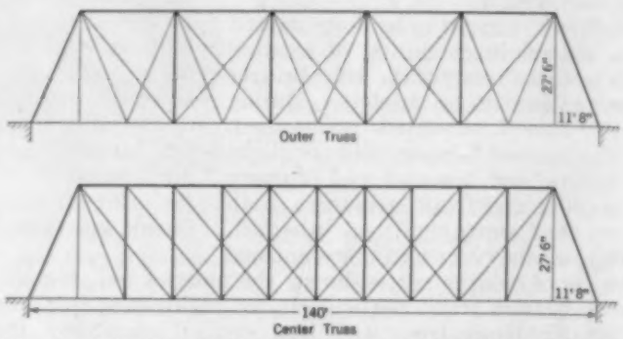


FIG. 4. A DOUBLE-TRACK IRON BRIDGE 140 FT LONG, BUILT IN 1881

On the Buffalo (N.Y.) Division of the Delaware, Lackawanna, and Western Railroad

At another time the lower iron casting of the rack circle in this same bridge became so worn that it had to be replaced. This was done by raising the span a few inches, first at one end and then at the other, thus teetering it up until the old casting could be removed. When the new steel casting was ordered, the local mechanic objected strongly, saying that it would break. When it was delivered he looked at the center mark scribed on it and said, "I told you so! The thing is cracked already!"

The span had temperature troubles also. It got the morning sun on one side and the evening sun on the other, so that one truss expanded more in the morning than the other and the opposite happened in the afternoon. As a result both ends could not be locked when the span was closed; when one end was locked the other had an extreme movement of $2^1/_2$ in. It was therefore necessary on the fixed span to keep 15 ft of the rails unspiked and held by bridle rods only, while the expansion of the rails on the draw span was taken care of by switch points. For part of the afternoon, when the highway floor shaded the lower chord, the top chord expanded more than the lower, so that the wedges had to be pulled

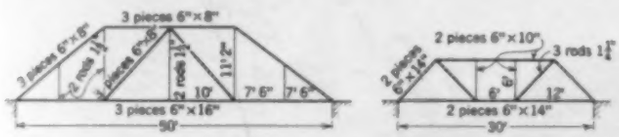
and reset at intervals, to prevent the span from bearing too hard on them.

In North Fort Worth, Tex., there was a small highway suspension bridge over a fork of the Trinity River, which had a "cable" consisting of a bunch of independent wires. It was evident that they were not equally stressed.

FEEDING THE TEREDO IN GALVESTON BAY

The old bridge over Galveston Bay, from Virginia Point to the island, was a trestle with a small Howe-truss draw span over the channel. The piers of the draw span were said to be of oyster-shell concrete, founded directly on the sand, which had been simply leveled off for the purpose. The trestle consisted of four pile bents of any kind of timber that was handy, and the teredo ate them away in a few months. The U.S. Engineer said his experience showed that, of two piles, one creosoted and the other not, the teredo would "a little rather" have the untreated one. This kept a pile-driver gang busy all the time, and any kind of timber that would drive was good enough. The caps were 12 by 12 in. and the stringers were 12 by 12 in. or 12 by 14 in., one under each rail. The panels were 12 ft long, and the ties were of pine, 2 by 8 in., cut off at the outer edge of the stringer. There was a fishing boat on the island shore, at the end of the trestle, with a good-sized hole in its bow. I was told that this was the result of a collision with an engine on the trestle, and it was not hard to believe.

I took soundings along the trestle, or rather measured its height above the sand, since the water at Virginia Point was only a few inches deep and deepened very slowly toward the channel. As the range of the tide was only a foot or so, I suggested that a fill be substituted for a large part of the trestle, but this idea was received with great scorn. However, when the present causeway was



Cayadutta Creek Bridge Mill Pond Bridge

FIG. 5. TWO EARLY WOODEN RAILROAD BRIDGES, NEW YORK

built, quite a lot of the trestle was replaced by embankment protected by concrete slabs.

STOWELL'S REPORT ON RAILROAD SPANS

The Report of the New York Railroad Commission for 1891 contains the report of an investigation by Charles F. Stowell, M. Am. Soc. C.E., on strains in railroad bridges in the State of New York. His investigation began in 1884, when the number of bridges in the state was about 2,500, not including elevated roads in New York City. Strains in plate girders were not included in the report. The board placed a limit of 10,000 lb per sq in. in tension on iron (apparently steel had not been used to any great extent) and 800 lb per sq in. in tension on wood, with a proportionate allowance in compression.

In his report Mr. Stowell stated:

> Cases constantly occurred, particularly in old bridges, where the iron in suspension rods was strained to 20,000 lb and more to the square inch, and where three or more rods constituted the member, there being no certainty that the adjustment was such that each rod was doing its share of the work.

Of several Howe-truss bridges he said:

> There were three trusses, all alike, although the center one (double track) carried as much as both the outside ones together .... Thus the chords were all alike, throughout the spans, notwithstanding the fact that one span is but 71 ft 6 in. long and 16 ft 6 in. deep, while another is 119 ft long and only 12 ft deep.
>
> Double track, 15-ft centers, no transverse iron floor beams; along the lower chord is an I-beam, supported by the chord pins at the foot of the tension members, and hangars and saddles at other points; these beams are 12½ in., 125 lb per yd for outer trusses, and 15 in., 180 lb for center truss; the ties rest on these beams.
>
> Many Howe trusses had a strengthening arch of wood, abutting against the pier or abutment; in only one was there a bowstring to the arch; this span was 139 ft, each truss had an arch, two pieces 6 by 10 in. springing from the lower chord each side of the truss; the bowstring was two rods 1¾ in. diameter along the lower chord.

Concerning an iron span he said:

> The floor consists of transverse I-beams, 9 in., 90 lb per yd, suspended from the lower chords, to which they are fastened by four 1-in. rivets at each end, passing through the top of the beams; one of these beams at the center of the panel, the other two about 2 ft 3 in. each side; on top of these beams two 6 by 6 by ⅝-in. angles are placed, 9 ft apart, running the full length of the bridge; the wood cross ties rest on these angles.

Another description states:

> The latter two members are the same size in all the trusses, though the stress in the center truss is nearly double that in the outside trusses; the ties are oak, 3 by 8 in., laid flat and widely spread; there is no guard rail.

Of still another bridge his description reads:

> Iron bridge, 83 ft 1¼ in., 7 panels. In the center panel of the center truss is one rod, strained 30,296 lb per sq in.; counter rod in next panel, 1⅛ in., strain 22,557; floor beams are riveted to under side of lower chords at points about 2 ft 3 in. apart, making each panel of chord a beam supporting floor and moving load, in addition to its proper use as a chord.

The report of Mr. Stowell also included sketches of all the spans he investigated, some of which were rather peculiar. In Fig. 3 are shown the details of a double-track iron bridge of 80-ft span, built in 1882 over the Oatke River. The panels are subdivided in an unusual manner. How the wind loads were provided for in the lower chords is not shown.

Bridge 36 on the Buffalo Division of the Delaware, Lackawanna, and Western Railroad, a double-track iron span 140 ft long, had outer trusses like the Oatke River span but the center truss was of the Pratt type. The trusses, placed 16 ft on centers, were divided into 12 panels, each 11 ft 8 in. long, as shown in Fig. 4. This bridge was built in 1881 and according to Stowell's rating was designed for a dead load of 2,700 lb per lin

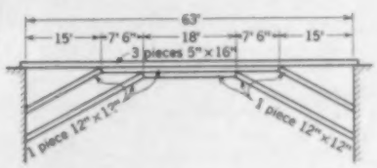


FIG. 6. GRASS RIVER BRIDGE, NEW YORK
Composed of Six 63-Ft Spans with Four Trusses in Each Span

ft, half of which was carried by the center truss and one-fourth by each outside truss. The moving load for each track consisted of 24,000 lb concentrated on each of four driving axles, 5 ft apart, followed by a uniform load of 3,000 lb per lin ft. This bridge had no floor beams and the track was supported on 8 by 14-in. oak ties, spaced

16 in. apart. The ties were laid on 15-in., 150-lb I-beams, held by chord pins along the bottom chord of each truss, there being one line of beams along each outer truss and two along the center truss. The upper chords were built up of two channels and a plate, and the lower chords consisted of bars about 1 by 5 in. in section.

Across Cayadutta Creek a wooden truss span 50 ft long was rated to carry a uniform dead load of 600 lb per lin ft of bridge and a concentrated moving load of 3,000 lb. The unequal length of the panels and the peculiar arrangement of the floor-beam hangers attached to the center of the end posts can be seen by reference to Fig. 5. This truss had no counterbracing.

Another wooden railroad bridge was designed for similar loading and also utilized iron rods for tension members. Although this Mill Pond span, Fig. 5, is but 30 ft long, its design is a little more daring than that of the Cayadutta Creek span, which it resembles.

The same report contains a sketch, Fig. 6, of the bridge over Grass River. Although the sketch does not show what the piers consisted of, the stresses in the struts *C* and *D* must have been transferred from span to span through them. In each of the six 63-ft spans there were four trusses like that in Fig. 6, one under each rail and one under the outer ends of the floor beams. The long diagonal seems to have been about 27 ft long, without intermediate support.

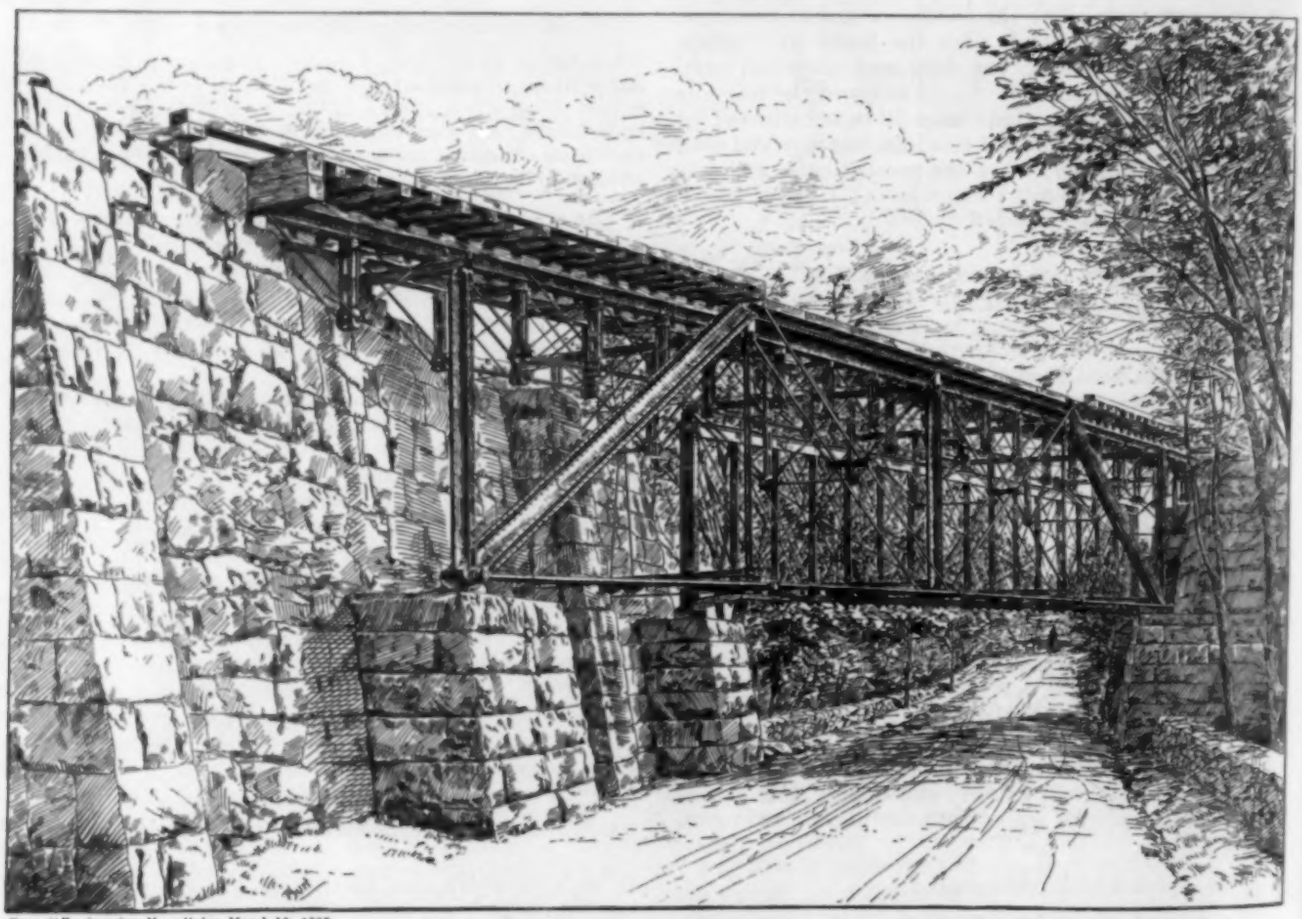
A prominent English engineer, Bindon B. Storey, in his book, *Storey on Strains*, gives descriptions of a number of girders found in English practice. Cast-iron beams, of I-section but "fish-bellied," with the lower flange wider than the upper, were common. He says:

> Cast-iron girders in one piece exceed 50 ft in length, though this is by no means the possible limit for single castings; for Sir John Hawkshaw has employed cast iron in single girders of 60 ft in length, and Fairbanks mentions a bridge with girders 76 ft long in one casting that were made in England and erected on the Haarlem Railway in Holland.

Cast iron was never used extensively in the United States, although it was employed for the upper chords of the Ashtabula and St. Charles bridges, with disastrous results. Also, some plate girders in a bridge near Connellsville, Pa., had cast-iron web stiffeners.

A good many years ago there was a bridge in Boston called the Bussey Bridge or the Tin Bridge, the failure of which is described in *Engineering News*, for March 19, 1887. In this remarkable structure, which spanned a street, one truss was a Pratt, the other a Whipple. The floor beams went from the panel points in the Pratt to alternate panel points in the Whipple.

In a textbook on *Bridge Building*, published by Squire Whipple (Squire was a part of his name, not a title) in 1847, were many drawings of old and peculiar spans. He was one of the very early writers on bridge stresses as well as the inventor of the Whipple truss, and is credited with being the first to show that the stresses in a member should be calculated by leverage.



From "Engineering News," for March 19, 1887

THE "TIN BRIDGE" NEAR FOREST HILL, BOSTON AND PROVIDENCE RAILROAD, AS IT WAS BEFORE ITS FALL ON MARCH 14, 1887

The Failure of This Hybrid Structure Under the Weight of a Passenger Locomotive Was Due to the Rupture of a Defective Hanger in the Near Truss. Owing to the Eccentric Position of the Track, This Four-Panel Truss, 16 Ft High, Carried Most of the Load. The Other Truss, 12 Ft. 6 In. High, Was Made up of 16 Panels.

Hauling and Erecting Large Steel Girders

Members for Approach Plaza of George Washington Bridge Maneuvered Under Difficulties

By WILLIAM G. RAPP

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STEEL erection is one of those fields in which the practical man has full scope. Often he finds that not the least of his troubles is to transport the fabricated members to the job, as was the case in building the approach plaza to the George Washington Bridge. The methods used in handling the massive steel girders for this structure form the basis of Mr. Rapp's story. The transportation through narrow streets of weights of 70 tons, in lengths of 120 ft, is not a matter to be taken lightly. He discusses the alternative plans proposed, with the pros and cons of each, and the ingenious methods finally adopted. This account of one phase of a huge job will appeal to all construction engineers.

IN THE erection of the steelwork for the approach plaza of the George Washington Bridge, on the New York City side, several interesting problems presented themselves. Among these were the delivery and erection of four continuous girders averaging 120 ft in length, three of them weighing between 68 and 70 tons, and the fourth 30 tons. The unusual size of these girders is accounted for by their function in supporting the upper bridge approach over the throat of the lower level, where the two vehicular tunnels in 178th and 179th streets merge as they near the bridge, Fig. 1.

While the weights of these members is by no means of record proportions, they were unusually large for handling on the street grades involved. Their lengths, in combination with the physical limitations of the adjacent highways, created a nice problem for the steel handlers. In planning their work, the first question to be decided was whether to bring in the four girders "knocked down," for riveting in the field, or to deliver them after they had been completely assembled in the shop. The latter method was adopted because of the difficulties of shipping the extremely long cover plates and angles and the inadvisability of attempting to rivet these parts with hand-operated pneumatic tools. The considerably higher cost of the handling in small units was a material factor in this decision.

Complete shop fabrication having been decided upon, the hauling subcontractor was called into conference. Arrangements were readily made to deliver the girders by rail at 135th Street, on the Hudson River, where a railroad wrecking car would unload them and place them on trucks. This appeared to be more practicable than delivery by lighter, with its higher charges for handling; furthermore, there was no available dock within the free lighterage limits any nearer to the bridge than the railroad.

From the railroad yard a wide street leads south to 125th Street, which has sufficient width to allow the loaded trucks to turn there toward the east. The next turn was from 125th Street into Broadway, another

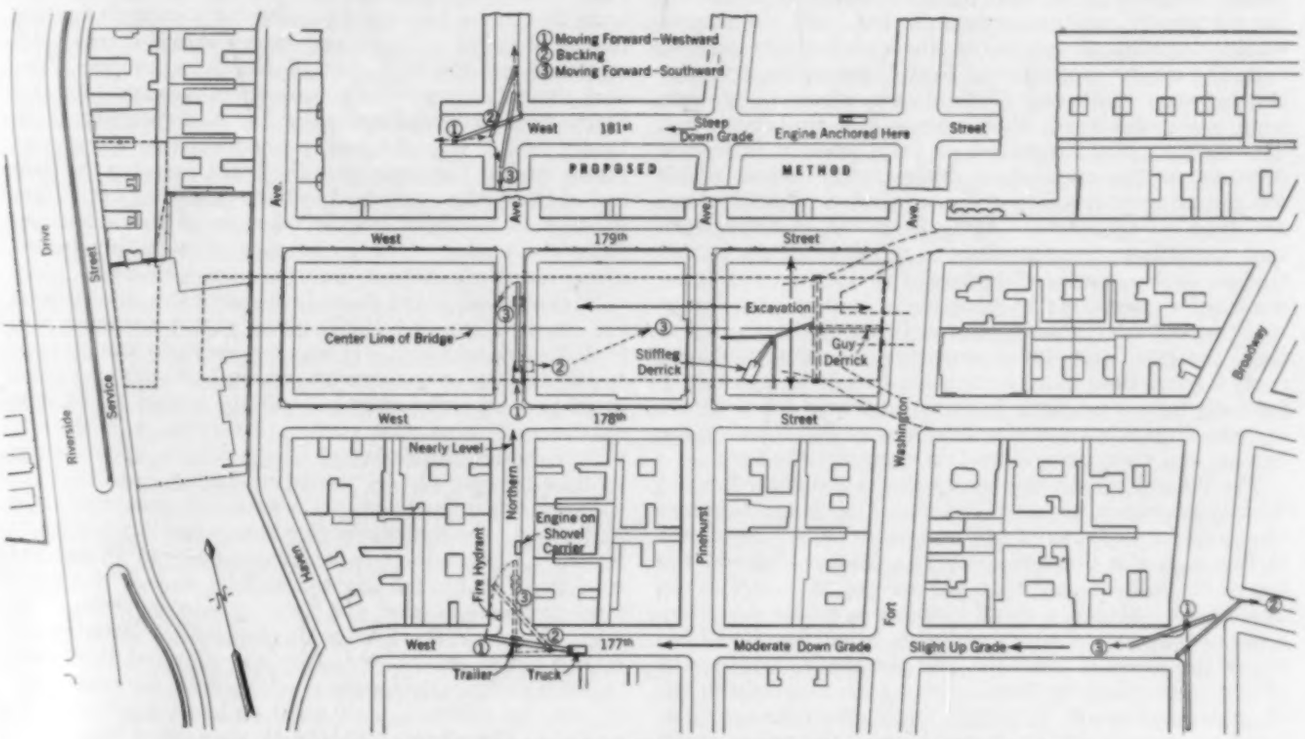


FIG. 1. PLAN OF THE STREETS NEAR THE GEORGE WASHINGTON BRIDGE, NEW YORK SIDE
Encircled Numbers Indicate the Sequence Used in Handling Girders at Critical Points

spacious thoroughfare, where an exceedingly wide swing was feasible, just clearing the sidewalks and the elevated steelwork of the "subway," which at this point is an elevated arch and viaduct structure in the center of Broadway.

Since Broadway is a wide, well paved street from 125th Street northward, the next question was how to deliver the girders at the bridge for erection. All the streets leading from Broadway to the site are relatively narrow, with the single exception of Fort Washington Avenue. But between 178th and 179th streets, where the girders were to be delivered, that avenue was timber-decked. The decking was supported on long wooden falsework columns to the excavation, immediately below which was the subway structure of the new Independent System, not then in operation. Aside from the inconvenience that would have been involved in moving the trucks and trailers over a timbered surface, the decking and falsework below were totally inadequate to support a heavy truck and trailer loaded with a 70-ton girder. It was then thought that these unwieldy vehicles could be routed from Broadway into 181st Street by starting a forward turn westward, backing east into 181st Street to help straighten out the long trailer for clearing the corner, and then going ahead to complete the turn.

The difficulty with this plan was that, slightly beyond Fort Washington Avenue (Fig. 1), 181st Street becomes too steep for such heavy and awkward loads. As shown in Fig. 1, it was planned to bring a 30-ton girder to the top of the hill, unload it on the pavement to act as an anchor, and attach a small gasoline hoist to it. Then a set of falls with a wire rope cable would be reeved between the drum of the hoist and the truck carrying the girder, permitting the truck to move westward down the steep grade towards Riverside Drive, the falls acting as a safety brake. At Northern Avenue the truck would again be maneuvered into a right-angle turn and thence driven on the level to the bridge approach.

GETTING READY FOR ERECTION
Unloaded Girder in Left Foreground and Another Being Brought in by Truck and Trailer

This plan was never carried out because the hauling subcontractor claimed that it was entirely too hazardous. Instead, he elected to use 177th Street, which, although narrower than 181st Street, is less steep. His plan, also illustrated in Fig. 1, was to bring the girders up Broadway on the wrong side of the street, against traffic. Since the hauling was done between midnight and 5 a.m., with a police escort, this was perfectly feasible. By a little maneuvering at the corner of Broadway and 177th Street, he backed his truck westward into 177th Street and up the slight grade between Broadway and Fort Washington Avenue. At the corner of 177th Street and Fort Washington Avenue he fastened two four-wheel trucks with wire rope slings to the front end of the loaded truck to act as brakes in moving down the moderate grade from Fort Washington Avenue to Riverside Drive. The truck continued to back until the west end of the girder, overhanging the trailer, was directly opposite the west building line of Northern Avenue. At this point large steel plates were laid on the pavement of Northern Avenue in the line along which the trailer was to be moved. The upper surface of the plates was then thoroughly greased, and a wire rope cable was led from the trailer to a small gasoline hoist securely fastened to the floor of a large and heavy shovel-carrier truck stationed on the east side of Northern Avenue. This and the following sequence of operations are indicated by the encircled numbers in Fig. 1. At a given signal, the loaded trailer was slid bodily northward on the greased plates, and at the same time the truck carrying the front end of the girder continued to back westward until it was in line with Northern Avenue, when the cable was removed from the trailer. The girder was then readily backed along Northern Avenue into the approach site.

It should be noted that, in making this 90-deg turn, the overhanging end of the girder would normally have fouled a fire hydrant. It was necessary to station a 15-ton caterpillar crane nearby, which at the proper point lifted the end sufficiently to clear the hydrant. In spite of the weight of the girder, this crane was able, by proper loading and control of the length of overhang, to take the sag out of the overhanging end.

Once inside the enclosure where the work was to be performed, the trucker's troubles were not yet over; for the girder had yet to be turned to lie in an east and west direction for delivery to a stiff-leg derrick, the means finally chosen to erect the four continuous girders. At this point the caterpillar crane took hold of the front end of the girder, which rested on the powered truck, and raised it sufficiently for the truck to drive out from under it, turn to the east, and back under it again at right angles to the girder. The truck then started eastward, pivoting the girder on the rear trailer with the assistance of a pull on the overhanging end from the engine mounted

on the shovel carrier. Since the ground was rutted, muddy, and soft in spots, it was extremely difficult for the truck to exert any real tractive force for pulling the girder around and down to the derrick. However, with the assistance of the donkey engine and the caterpillar crane, all the girders were finally delivered to the stiff-leg derrick, and the work of the hauling subcontractor was done.

Next, a decision had to be made as to the method of erecting the heavy girders. Inasmuch as the rest of the steel in the approach plaza could all be handled by one or two caterpillar cranes of 15-ton capacity, the question was whether it would be expedient to set up a heavy derrick (a stiff-leg type being the only feasible one due to conditions at the site) in order to erect the three 70-ton girders, or whether to teeter them into place.

This latter method consists in sliding the girder off the truck sideways on to two sets of blocking at the same elevation as the girder on the truck. By properly placing these blocks, the overhang at each end is such that the girder will just balance on either set of blocking when a lift of 15 tons is applied to the opposite end. This pull was adopted as being the capacity of the particular cranes it was planned to use. One crane would lift its end of the girder high enough off its support so that additional timber blocking could be inserted. Then the crane at the other end would repeat the operation, and thus the girder would rock back and forth, first teetering on one set of blocking and then on the other, rising each time. When raised to the proper elevation, the girder would be turned from its side to its proper upright position and jacked or pulled over into place on three supporting columns, over which it was continuous.

Finally the teetering method was discarded on account of the difficulty of placing the girder by truck exactly in line with its final position, and because of the construction of the columns, a single center column being designed to take the three heavy girders. Other factors, such as cost, safety, and time, were also unfavorable to this method. Accordingly it was decided to use the stiff-leg derrick previously mentioned, and to weigh it down with one- and two-ton blocks. Such a derrick could be easily brought to the site and later removed, and would have the power to lift the girders and set them in place quickly, economically, and safely. It would then be in position to erect efficiently much of the other steel, which otherwise would have had to be placed by the slower tractor cranes. With the powerful derrick, steel could be unloaded in heavy drafts and erection greatly facilitated.

On account of the many connections between the three heavy girders, all the diaphragms on both sides of the center girder were fastened to it on the ground, increasing its weight to about 80 tons, and the whole was then erected. The two girders on each side were next placed in position and slid in sidewise to connect to the diaphragms. A space just sufficient for a man to enter was left between the girders so that the diaphragms could be riveted.

Caterpillar cranes were employed to erect and remove the stiff-leg derrick. The gasoline hoist used with the derrick was unloaded by means of skids and rollers and hauled away on a low shovel-carrier truck on account of its bulk and its weight, which was over 30 tons. The complete hoist was 12 or 13 ft wide and about 26 ft long.

THE 120-FT GIRDERS IN PLACE, AS VIEWED FROM PINEHURST AVENUE IN MARCH 1931
Tunnels from Streets at Right and Left Converge Here

Once the girders were up, the erection of the remainder of the steel in the plaza was comparatively simple, except for that directly under Fort Washington Avenue. There it was necessary to station a crane on the street level above, its cable running through a hole bored in the timber decking directly over the center of the piece to be erected. A guy derrick (Fig. 1) was set up to place the steel on the ground under the decking, and the crane overhead lifted the beams and girders into place. In a few instances it was necessary for the crane to hook on to one end of some of the heavier girders while the guy derrick picked up the other end. This method of erection by guy derrick and crane, through the decking, was necessary because of the restrictions imposed by the new subway under Fort Washington Avenue and because of the traffic overhead. The erector was not permitted to remove any of the decking and thus tie up traffic. Not only was there insufficient headroom for a crane to work below, but the roof of the new subway had been freshly poured and would not sustain such a load.

There are about 1,700 tons of structural steel in the approach plaza between Fort Washington and Northern avenues. With the exception of the three heavy continuous girders, the steel consists of columns, beams, and girders, none weighing more than about 30 tons.

The steelwork for this section of the bridge project was fabricated and erected by the McClintic-Marshall Corporation, for which the writer served as field engineer.

Road Testing Car with Gas-Electric Drive

Tractive Resistance Measured at Iowa State College

By RAYMOND G. PAUSTIAN
JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTRUCTOR IN CIVIL ENGINEERING, IOWA STATE COLLEGE, AMES

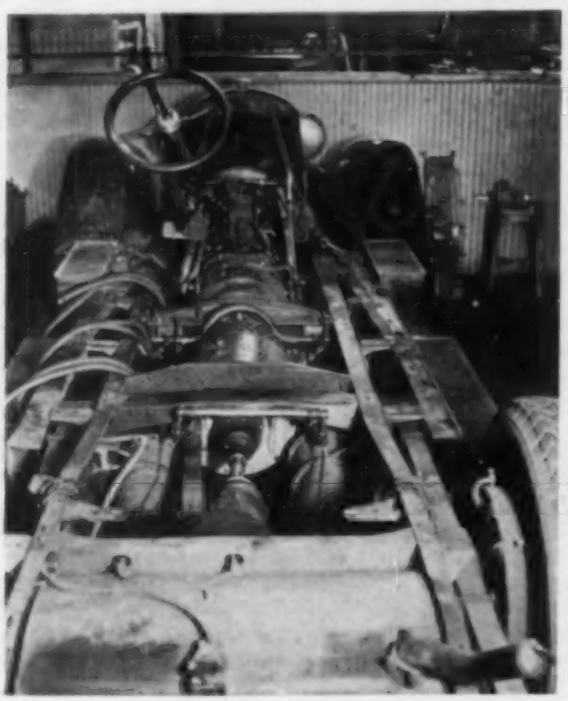
AUTOMOBILE owners, in appraising the roads over which they must drive, think first in terms of personal comfort and speed. But whenever expenditures for taxes and gasoline are carefully considered, they must think also in terms of operation cost. This item is affected by various factors: type of road surface, weather conditions, tire pressure, delays due to traffic, and even the shape of the vehicle itself. In this article, Mr. Paustian describes a unique test car equipped with a gas-electric drive, used at the Iowa Engineering Experiment Station to investigate and accurately determine the forces resisting a car when it is traveling on the road. Some of the results are indeed surprising. It is evident that this experiment station is conducting valuable researches.

HIGHWAY engineers and others have long been interested in evaluating the forces that act upon vehicles while they are traveling on a highway. As early as 1842 Morin analyzed and determined the magnitude of the forces that resisted the motion of horse-drawn vehicles on various types of roadway surface. Numerous investigations have been completed since that time, but have failed to furnish the needed data for determining accurately the power required to overcome all external and internal resisting forces while the vehicle is moving on the road surface under its own power. The present investigation was begun by the Iowa Engineering Experiment Station several years ago, and progress reports have been made from time to time.

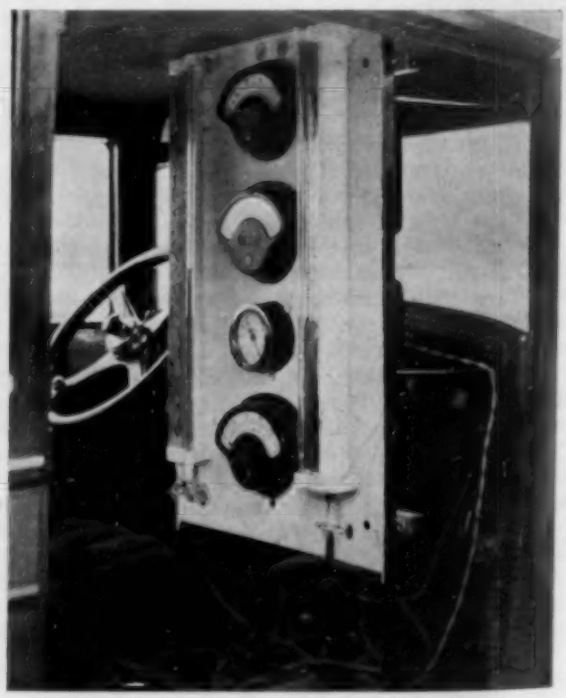
The total of the forces that resist the motion of a vehicle may be termed the "tractive resistance." On a level surface, the two major elements are the "rolling resistance" and the "air resistance." An additional force, known as "grade resistance" is present on a slope.

Rolling resistance includes the retarding force of such items as friction in wheel bearings, tire walls, and tread; deformation of the road surface; and irregularities in this surface. Air resistance is made up of two factors, skin friction and form resistance. Skin friction occurs in the layers of air lying close to the body of the car and is a comparatively small item—15 per cent of the total. Form resistance represents the remaining 85 per cent and is caused by turbulence in the air resulting from the motion of the vehicle. If the body of the car were shaped so as to create no turbulence when passing through the air, this factor would be reduced to zero. The third force, grade resistance, is the component of the force of gravity, that is, of the vehicle's gross weight, which tends to make it roll down hill.

Before entering into a description of the present equipment and the reasons for its choice, it might be well to discuss the limitations under which previous investigations have been conducted. Three methods of determining tractive resistance have heretofore been more or less commonly used: towing, deceleration, and coasting. The first method consists of pulling the test car with a long rope and measuring the pull with some



Standard Auto Chassis Adapted for Gas-Electric Drive



Instrument Panel of the Road Testing Car

ROAD TESTING CAR DEVELOPED AT IOWA ENGINEERING EXPERIMENT STATION

type of dynamometer. Such tests are limited in scope because only low speeds are possible, and because the towing vehicle so disturbs the air that it is impossible accurately to determine the resistance of the air to the vehicle towed.

Deceleration tests, made by allowing the vehicle to coast from a higher to a lower speed on a fairly level surface, are difficult to interpret because the moment of inertia of all rotating parts must be considered in calculating the value of the resisting force. Coasting tests are made by noting the speed at which a vehicle coasts down a grade. At a constant speed, the forces resisting its motion are balanced by the downward component of the weight of the car. In so far as high speeds are concerned, certain limitations are evident in each of these methods. Their outstanding weakness, however, lies in the fact that the vehicle does not operate under its own power.

GAS-ELECTRIC DRIVE USED

As a result of the limitations of previous equipment, the following specifications governing the construction of the test car used at the Iowa Engineering Experiment Station were determined upon: The vehicle must be capable of operating at the speeds now prevailing on highways, from 50 to 65 miles per hr; the car's performance and power requirements must be recorded under all operating conditions; and these data must be supplemented by accurate measurements of gasoline consumption.

To meet these requirements, a car with a gas-electric drive was constructed. Briefly, the equipment consists of a standard automobile in which the transmission has been replaced with an electric generator, motor, and the necessary control equipment. A view of the chassis assembly is shown in one of the accompanying photographs.

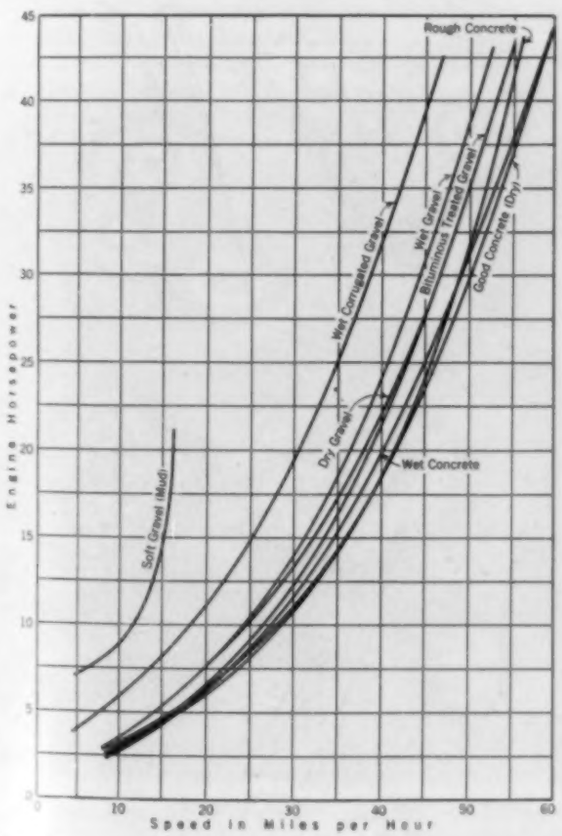


FIG. 1. EFFECT OF ROAD SURFACE ON HORSEPOWER REQUIRED

The car is operated in the usual manner, that is, by the use of the accelerator pedal. Electrical energy is developed by the generator in accordance with the speed of the gasoline engine and the power requirements of the electric motor that drives the rear wheels. Motion forward or backward is controlled through a drum-type switch similar in appearance to that used in a trolley car. There being no mechanical connection between the gasoline engine and the rear wheels, the car is a perfect exemplification of "free-wheeling."

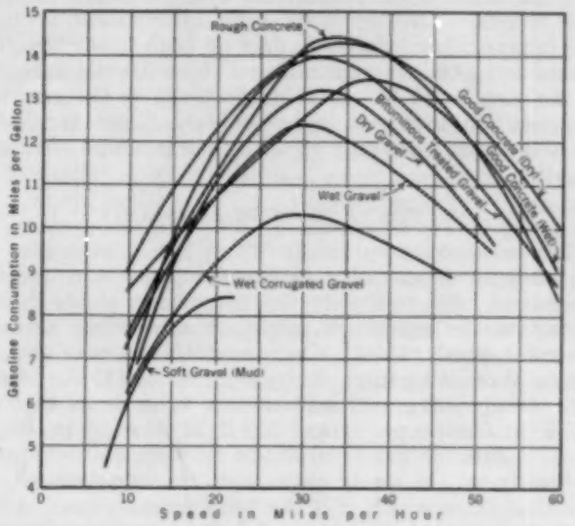


FIG. 2. EFFECT OF ROAD SURFACE ON GASOLINE CONSUMPTION

ROAD TESTING CAR EQUIPPED WITH COMPLETE RECORDING APPARATUS

The electrical energy developed by the generator is metered and the readings of the meters recorded. A record of the power required to overcome all internal and external resistances, such as bearing resistances, tire resistance, air resistance, and road resistance, is thus obtained while the vehicle is operating under its own power. It might be interesting to note that current readings of from 100 to 550 amp at a potential varying from zero to 250 v are common.

A photograph of the instrument panel shows the meters mentioned, the two gasoline gages (burettes graduated to 0.0025 gal), the accurate speed indicator, and the half-second timing device. The remaining equipment consists of a "space-time" recorder of the usual paper ribbon type, which furnishes an accurate record of the time and distance traveled. It is evident that the recording equipment gives an accurate record of the car's performance.

The car was calibrated by using a chassis dynamometer to determine the losses in the various parts of the vehicle due to such factors as friction and windage. From the calibration tests it was also possible to find what percentage of the engine horsepower was transmitted to the road surface. In brief, the tests showed an efficiency as high as 80 per cent at certain speeds and under certain conditions. A maximum over-all thermal efficiency of 12 per cent was noted.

Since the completion of the calibration tests, a large number of road tests have been made. The purpose of these has been to determine the effect of the road surface on both power requirements and gasoline consumption. The results are clearly shown in Figs. 1 and 2.

During the time that these road tests were made, several interesting things were noted. The first of these was that the diameter of the tires increased approximately one-half inch as the speed increased from zero to 60 miles per hr. This of course means that the wheels of a car make fewer revolutions at high speeds than at low speeds. Another interesting observation is that tire inflation has a decided effect on both power requirements and gasoline consumption. The normal inflation of the tires is 45 lb. If it drops to 35 lb the gasoline consumption increases approximately 8 per cent and there is a corresponding effect on the amount of power required.

ANALYSIS OF TRACTIVE RESISTANCE

The horsepower curves shown in Fig. 1 were used as the basis for determining various components of tractive resistance. To exemplify the magnitude of the forces acting on the vehicle it might be interesting to note several typical values. On a smooth concrete surface the total resisting force varies from 80 to 215 lb. On a soft corrugated gravel surface this value is as high as 145 lb at 5 miles per hr and 350 lb at 50 miles per hr.

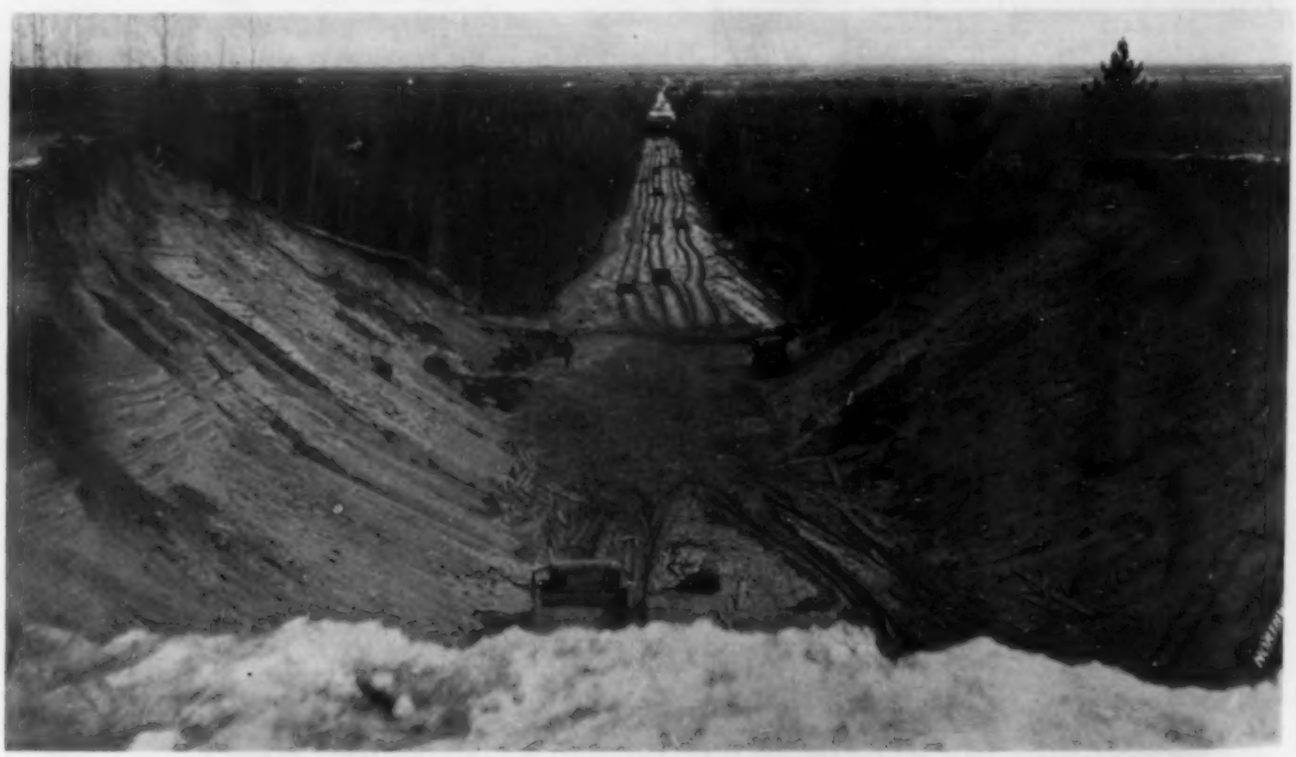
Air resistance has been found to vary as the square of the speed, in accordance with the equation, $R = 0.0017\,AS^2$, in which R is the total resisting force, A the projected area of the car, and S the speed in miles per hour. The importance of this factor may be realized when it is noted that at a speed of 60 miles per hr, the air resistance makes up about 65 per cent of the total resistance. The advantage of reducing this item is at once apparent and accounts for the degree of streamlining noticeable in the newer models.

To give a single example of the usefulness of the foregoing data, the following analysis is presented. From the curves for gas consumption in Fig. 2, it is apparent that the optimum speed for economy of operation is approximately 35 miles per hr—much less than the speeds at which most cars are now operated. There should be, and is, some monetary value in driving at this lower speed.

HIGH SPEEDS USUALLY NOT ECONOMICALLY JUSTIFIED

Suppose that a person drives between two cities 35 miles apart, once at a speed of 35 miles per hr and again at that of 60 miles per hr. The curves in Fig. 2 show that at 35 miles per hr the gasoline consumption is 14.3 miles per gal, and at 60 miles per hr it is 10 miles per gal. When the trip is made at a speed of 35 miles per hr, 2.45 gal of gasoline are used and the time required is one hour. At a speed of 60 miles per hr, the time required is 35 min, but the gasoline used is 3.50 gal. There is a time saving of 25 min, but at the expense of 1.05 gal of gasoline, which, at 20 cents per gal, increases the cost by 21 cents. It can readily be calculated that the driver's time should be worth at least 50 cents per hr to justify the higher speeds from an economic standpoint. The foregoing estimate includes only gasoline costs and takes no account of the effect of higher speeds on oil consumption, tire wear, car maintenance, and fatigue of the driver.

In summarizing the results of the investigation, it is of particular significance to note that the equipment used provides an accurate and practical method for determining and analyzing the forces acting on a vehicle as it travels on the highway. The completion of these tests should result in discoveries of the utmost importance to highway engineers.



WINTER GRADING OF NEW ROAD LOCATION, DELTA COUNTY, UPPER PENINSULA, MICHIGAN
Route M-186, Michigan State Highway System
Between Rapid River and Brampton

Demonstrating the Economy of Good Roads

State Highway Department Shows That in Michigan Good Roads Save Their Cost, Provide Work Relief, and Are Half as Expensive as Five Years Ago

By A. C. Benkelman

Research Engineer, The Michigan State Highway Department, Lansing, Mich.

MOTORISTS have seen good roads grow into one of the greatest educational and stimulating devices the world has ever known. The country adds to its taxable wealth, improves its well-being, its health, and its social life, through the extension of this means of communication. Car owners—even the general public—appreciate the highways in a casual way, but too few people realize that good roads save more than they cost; that road building provides maximum relief for unemployment; and that, with the same expenditure of money, it is possible now to build nearly twice the road mileage that could have been built five years ago.

To bring such basic facts home to the public in terms of dollars and cents—that was the aim of the Michigan State Highway Department when it made up its exhibit for the Highway and Building Congress, held in Detroit, January 16–20 of this year. The same exhibit was also shown at the annual Detroit Automobile Show and at several meetings of highway engineers and officials in the state.

Good roads save more than they cost, the exhibit demonstrated, not because the initial cost is less but because expenditures for surface maintenance and vehicle operation are less. As a part of the exhibit, the data shown in Table I were presented under the caption, "Surfaced Roads Reduce Car Operating Costs."

IT is one thing to say that the unique position of road construction as a producer of work and wealth needs dramatizing to impress it on the public; it is another thing to stage the drama so that it will impress the average citizen. However, this much-needed job of dramatization was done at the Highway and Building Congress in Detroit, and done exceedingly well. The Michigan State Highway Department performed a valuable service in presenting its action exhibit to those who attended the congress and to numerous groups of state officials and highway engineers elsewhere. The data presented here and the conclusions drawn from them apply specifically to conditions in Michigan, which may be more favorable than those in other parts of the country where road building materials are less readily available.

Assuming a cost of 7 cents per mile on an earth road, the savings indicated, when translated into cost of car operation per mile, give values of 6 and 5 cents for gravel and pavement types, respectively. These three values for cost of travel were demonstrated in such a manner that even the casual observer was made to realize that surfaced roads do indeed reduce car operating costs. This was done by a mechanical contrivance shown in one of the accompanying illustrations. On looking through a window 6 ft long and 2 ft wide, directly beneath the data on the itemized car dollar, the observer saw in the distance a miniature stationary automobile under which moved in succession a pavement, a gravel road, and an earth surface. The tiny car pulled against a coiled spring, the extension of which operated a pointer over a scale indicating car operating costs of 5, 6, and 7 cents per mile. On the earth, or unimproved section, the pull was greater, and the pointer oscillated between $6\frac{1}{2}$ and $7\frac{1}{2}$ cents. On the gravel section it oscillated between $5\frac{1}{2}$ and $6\frac{1}{2}$ cents, and on the pavement, because the pull was less and decidedly more uniform, it remained practically motionless at 5 cents. At its extreme end the pointer moved through a distance of approximately 6 in. as the road type changed from pavement to earth, so that the effect of the difference in pull was readily discernible.

Dramatizing the Costs of Automobile Operation—Exhibit of the Michigan State Highway Department
Three Types of Roads Are Moved Successively Under a Miniature Auto

The demonstrated values for cost of car travel over gravel and pavement surfaces were then used in a series of graphs and computations, shown in Fig. 1, which

AERIAL VIEW OF THE DUNES HIGHWAY (U.S. 31)
A Relocation Project Along the Shore of Lake Michigan

served to illustrate the relative economy of the two types. Under the caption, "Paved Roads Are a Good Investment," four sets of curves were shown: the first portraying the annual road cost per mile; the second, the annual vehicle operating cost; the third, the total or annual transportation cost (the sum of the road and vehicle operating costs); and the fourth, savings in the annual transportation cost made possible by a change of road type from gravel to pavement. Costs were computed for increasing intensities of traffic up to 3,000 vehicles per day. The curves in Fig. 1 show the relationship between the annual cost and traffic density. The computed values of annual cost used in plotting the graphs are given in Table II, as follows:

TABLE I. WHERE THE CAR OPERATOR'S DOLLAR GOES ON THREE DIFFERENT TYPES OF ROADS

Computed from Data Published by the Iowa Engineering Experiment Station, Ames, Iowa

TYPE OF ROAD SURFACE	INSURANCE, INTEREST, AND GARAGE RENT	DEPRECIATION	MAINTENANCE	TIRES AND TUBES	OIL AND GAS	SAVINGS	TOTAL
Pavement . .	$0.15	$0.17	$0.20	$0.04	$0.16	$0.28	$1.00
Gravel . . .	0.15	0.19	0.24	0.09	0.18	0.15	1.00
Earth	0.15	0.21	0.29	0.12	0.23	None	1.00

TABLE II. SAVINGS IN ANNUAL TRANSPORTATION COST EFFECTED BY A CHANGE FROM A GRAVEL SURFACE TO A PAVEMENT

V_t = traffic in vehicles per day
C = annual construction cost
M = total maintenance cost per year (from Michigan records covering 2,500 miles of pavement and 3,000 miles of gravel)
V = annual vehicle operating cost
T_p = annual transportation cost for pavement
T_g = annual transportation cost for gravel
S = savings in annual transportation cost per mile effected by a change in type of surface from gravel to pavement—T_g to T_p

	PAVEMENT				GRAVEL				
V_t	C	M	V	T_p	C	M	V	T_g	S
50	$1,518	$290	$ 913	$2,721	$506	$ 640	$1,049	$2,195	$ ...
100	1,518	300	1,825	3,643	506	730	2,098	3,334	...
250	1,518	325	4,563	6,406	506	870	5,245	6,621	215
500	1,518	360	9,125	11,003	506	1,000	10,490	11,996	993
750	1,518	395	13,688	15,601	506	1,105	15,735	17,346	1,745
1,000	1,518	430	18,250	20,198	506	1,195	20,980	22,681	2,483
1,500	1,518	500	27,375	29,393	506	1,345	31,470	33,321	3,928
2,000	1,518	570	36,500	38,588	506	1,470	41,960	43,936	5,348
3,000	1,518	695	54,750	56,963	506	1,710	62,940	65,156	8,193

In the following tabulation are given the basic values used in the computations:

Initial cost, including grading and drainage:
- For pavement, $25,000 per mile
- For gravel, $10,000 per mile

Depreciation, or periodic maintenance cost:
- For pavement, 60 per cent during the first 25 years and 40 per cent during the next 50 years
- For gravel, 100 per cent in 50 years

Maintenance for both pavement and gravel, taken from Michigan records

Cost of vehicle operation:
- On pavement, 5 cents per mile
- On gravel, 5¾ cents per mile

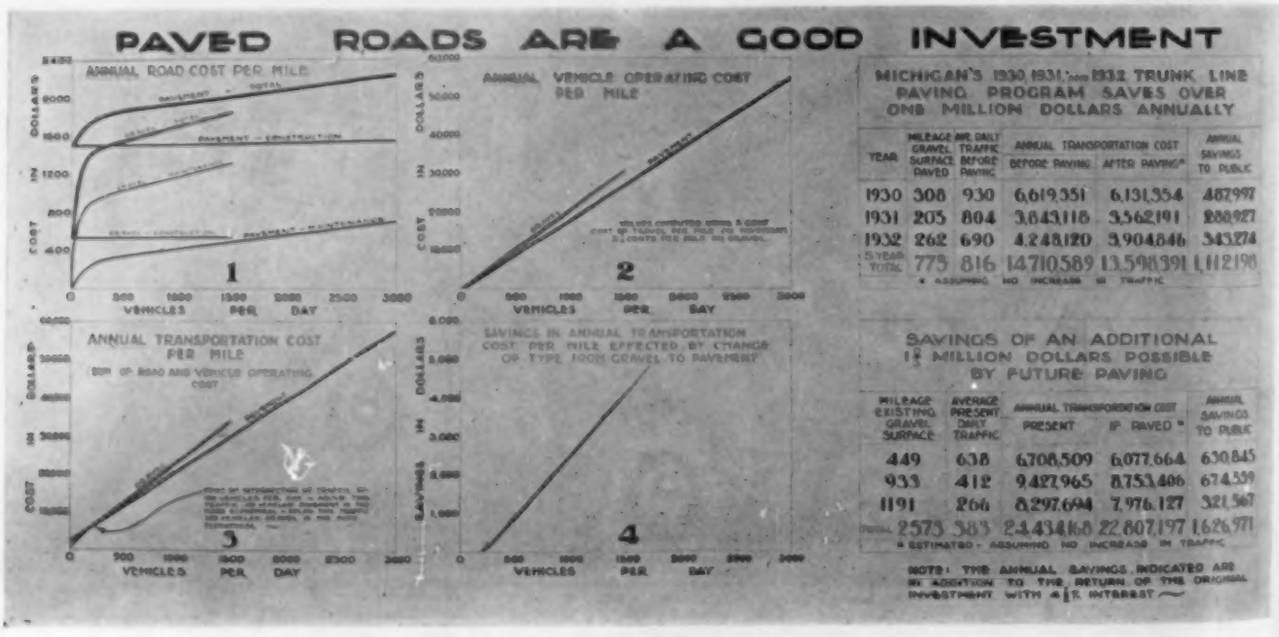

PAVED ROADS ARE A GOOD INVESTMENT
ANNUAL ROAD COST PER MILE
ANNUAL VEHICLE OPERATING COST PER MILE
ANNUAL TRANSPORTATION COST PER MILE
SAVINGS IN ANNUAL TRANSPORTATION COST PER MILE EFFECTED BY CHANGE OF TYPE FROM GRAVEL TO PAVEMENT
DOLLARS
COST
VEHICLES PER DAY
1
2
3
4
MICHIGAN'S 1930 1931 and 1932 TRUNK LINE PAVING PROGRAM SAVES OVER ONE MILLION DOLLARS ANNUALLY
YEAR
MILEAGE GRAVEL SURFACE PAVED
AVE. DAILY TRAFFIC BEFORE PAVING
ANNUAL TRANSPORTATION COST BEFORE PAVING
ANNUAL TRANSPORTATION COST AFTER PAVING*
ANNUAL SAVINGS TO PUBLIC
1930 308 930 6,619,351 6,131,354 487,997
1931 205 804 3,643,118 3,562,191 280,927
1932 262 690 4,248,120 3,904,846 343,274
5 YEAR TOTAL 775 816 14,710,589 13,598,391 1,112,198
* ASSUMING NO INCREASE IN TRAFFIC
SAVINGS OF AN ADDITIONAL 1¼ MILLION DOLLARS POSSIBLE BY FUTURE PAVING
MILEAGE EXISTING GRAVEL SURFACE
AVERAGE PRESENT DAILY TRAFFIC
ANNUAL TRANSPORTATION COST PRESENT
IF PAVED *
ANNUAL SAVINGS TO PUBLIC
449 638 6,708,509 6,077,664 630,845
933 412 9,427,965 8,753,406 674,559
1191 266 8,297,694 7,976,127 321,567
TOTAL 2573 383 24,434,168 22,807,197 1,626,971
* ESTIMATED - ASSUMING NO INCREASE IN TRAFFIC
NOTE: THE ANNUAL SAVINGS INDICATED ARE IN ADDITION TO THE RETURN OF THE ORIGINAL INVESTMENT WITH 4½% INTEREST

FIG. 1. MICHIGAN STATE HIGHWAY EXHIBIT AT THE HIGHWAY AND BUILDING CONGRESS, DETROIT

The cost data given by T. R. Agg, M. Am. Soc. C.E., in Bulletins of the Iowa State College Experiment Station indicate a difference of 1 cent per mile between cost of vehicle operation on intermediate and on high-type surfaces. A value of $^3/_4$ cent was used to represent this difference for gravel and pavement surfaces in Michigan. Dean Agg's data also indicate a general average vehicle operation cost of $5^1/_2$ cents per mile on pavement, which has been reduced to 5 cents per mile for conditions in Michigan.

A mile of concrete pavement built by the Michigan State Highway Department costs in general about double as much as the same amount of gravel surface. Had this ratio of cost been used in the analysis instead of $25,000 and $10,000, the savings which it was estimated could have been effected by paving would have been somewhat larger. This is another evidence that conservative data were used throughout the entire analysis.

The annual construction cost was computed by the formula:

$$C = EA\left(\frac{1}{S_n} + i\right) + E'A\left(\frac{1}{S_{n'}} + i\right) \quad . \quad . \quad [1]$$

in which:

C = annual construction cost
A = cost of construction
i = interest rate
E = expenditure for periodic maintenance in percentage of A every n years
E' = expenditure for periodic maintenance in percentage of A every n' years
S_n = amount of annuity of $1 for n years
$S_{n'}$ = amount of annuity of $1 for n' years

For the annual road cost the following formula was used:

$$R = M + C \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

in which:

R = annual road cost
M = total maintenance cost per year (from Michigan records)

The annual vehicle operating cost was computed by the formula:

$$V = V_t \times 365 \times V_m \quad . \quad . \quad . \quad [3]$$

in which:

V = annual vehicle operating cost
V_t = traffic in vehicles per day
V_m = vehicle operating cost per mile

The formula used for computing the annual transportation cost is:

$$T = R + V_m \quad . \quad . \quad . \quad . \quad . \quad [4]$$

in which

T = annual transportation cost.

In the final analysis these four formulas are the same as those published by the Highway Research Board.

A SAMPLE SOLUTION

Consider, for example, a theoretical problem, assuming the following values:

A = $25,000	n = 25 years
i = $4^1/_2$ per cent	n' = 50 years
M = $360 (from records)	V_t = 500 vehicles per day
E = 60 per cent	V_m = 5 cents per mile
E' = 40 per cent	

From annuity tables, take $\left(\frac{1}{S_n} + i\right)$ to equal 0.0674390 and $\left(\frac{1}{S_{n'}} + i\right)$ to equal 0.0506022. Then, by Formula 1,

$$C = (0.60 \times 25{,}000 \times 0.0674390) + (0.40 \times 25{,}000 \times 0.0506022) = \$1{,}518$$

By Formula 2,

$$R = \$360 + \$1{,}518 = \$1{,}878$$

By Formula 3,

$$V = 500 \times 365 \times \$0.05 = \$9{,}125$$

and, by Formula 4,

$$T = \$1{,}878 + \$9{,}125 = \$11{,}003$$

From Fig. 1, Chart 3, it will be noted that the curves for annual transportation cost over gravel and pavement intersect at a comparatively low traffic density. The

FIG. 2. PICTURING A LOCAL PROJECT TO ITS USERS

point of intersection indicates that in this analysis the economy of the two types was equal at a traffic volume of 190 vehicles per day.

PRACTICAL APPLICATION OF COST STUDIES

In order to illustrate the practical application of cost studies of this nature, the results of certain computations pertaining to Michigan's trunk-line system were presented in the exhibit (Fig. 1) under the title, "Michigan's 1930, 1931, and 1932 Trunk-Line Program Saves Over One Million Dollars Annually." In addition to the $1,112,198, given as the annual savings in transportation cost resulting from this three-year program, is the yearly return of $4^1/_2$ per cent interest on the original cost of the pavement and provision for rebuilding when necessary. An analysis of this nature, involving the entire mileage of paved highways on Michigan's trunk-line system, without taking into consideration traffic increases or savings in travel time, would disclose annual earnings in excess of $10,000,000.

FURTHER SAVINGS POSSIBLE

In the same exhibit, as a part of the same story, additional data dealing with future paving of gravel roads were presented. Under the caption, "Savings of an Additional 1 and $^2/_3$ Million Dollars Possible by Future Paving," was listed the mileage of gravel roads carrying traffic of: (1) 500 vehicles and over, (2) 350 to 500 vehicles, and (3) 190 to 350 vehicles per day; also, the present annual transportation cost and what it would be on a basis of present unit prices, if a pavement were substituted.

Four location sketches of the Dunes, Soo, Dort, and Mancelona-Kalkaska highways, respectively, were used in the exhibit to show how improvements paid for themselves at specific locations. One of the sketches is shown

in Fig. 2. Studies of transportation cost for these four highways were made using Formulas 1, 2, 3, and 4 to compute the various values of annual cost. For cost of construction, the exact amount was used, as shown by the records of the State Highway Department, and the cost records of the Michigan State Highway Department for road building, was also utilized in the exhibit. It is given in Tables IV and V.

The data in these tables are largely self-explanatory. It is of particular interest to note, however, that a million dollars would build as great a mileage of concrete pavement in 1932 as of gravel road in 1928. The cost of laying one mile of concrete surface for any one of the years indicated would be approximately the difference between the cost of grading and drainage and that of the concrete pavement complete.

The experience of the Michigan State Highway Department may be briefly summarized. A paved road costing $25,000 per mile becomes more economical than a gravel road costing $10,000 per mile at a traffic of 190 vehicles per day. The paving of 775 miles of gravel road on the Michigan trunk-line system in 1930, 1931, and 1932 saved over $1,100,000 annually in transportation cost in addition to interest at 4.5 per cent on the investment and depreciation charges. The paving of 1,191 miles of existing gravel surface on the system, carrying a traffic of 190 to 1,500 vehicles per day (an average of 383), would effect savings of more than $1,600,000 annually over and above depreciation and interest charges.

TABLE III. MICHIGAN'S 1931–1932 WINTER RELIEF PROGRAM

Of the $14,750,000 Expended, Approximately $6,650,000 Was Paid to Labor on the Work and $6,770,000 (in Part Estimated) to Labor in Allied Industries

LOCATION IN STATE	MONEY EXPENDED	PAID DIRECTLY TO LABOR ON THE WORK			PAID INDIRECTLY TO LABOR		TOTAL PAID TO LABOR	
		Amount	Percentage	Man-Hours at 35¢ per Hr	Amount	Percentage	Amount	Percentage
Division 1	$ 3,515,950	$1,560,875	45	4,459,643	$1,632,767	46	$ 3,193,642	91
Division 2	2,932,481	1,315,511	45	3,758,602	1,351,302	46	2,666,813	91
Division 3	3,304,077	1,470,348	45	4,200,994	1,531,051	46	3,001,379	91
Division 4	2,952,259	1,291,479	44	3,689,940	1,389,557	47	2,681,036	91
Division 5	2,046,677	1,013,814	50	2,896,612	863,420	42	1,877,234	92
TOTALS FOR THE FIVE DIVISIONS								
Road and bridge construction	$ 8,944,014	$3,577,605	40	10,221,728	$4,472,007	50	$ 8,049,612	90
Betterments	1,736,130	1,388,904	80	3,968,297	260,420	15	1,649,324	95
Road and bridge maintenance	4,071,300	1,685,518	41	4,815,766	2,035,650	50	3,721,168	91
Grand total	$14,751,444	$6,652,027	45	19,005,791	$6,768,077	46	$13,420,104	91

same was true of the total yearly maintenance cost on the respective highways.

In the case of the Dunes Highway, for example, the total vehicle operation cost (for 1,400 cars a day) was $462,455 as against $546,708 on the old route. The transportation cost was $549,888 as against $646,570 on the old route—a saving of $96,582. However, $26,922 of the annual road cost of the old road was deducted from the savings estimated, because the old route was retained for the benefit of local traffic. Thus the net annual savings were given as $96,582 less $26,922, or $69,660.

ROAD BUILDING AND UNEMPLOYMENT

That road building affords maximum relief for unemployment was vividly shown in the exhibit by the presentation of statistical data pertaining to Michigan's winter construction program for 1931 and 1932. Careful records were maintained by the State Highway Department during the period in question as to the number of men employed and the amount of money expended for labor. The data are given in Table III.

It is to be noted that, by this analysis, 45 per cent of the money expended on all classes of work in Michigan was paid directly to labor on the job. The percentage of the total expenditure paid directly to labor for "road and bridge construction" is practically the same as that for "road and bridge maintenance," but that for "betterments" done under maintenance is almost twice as great. This is due to the fact that betterment work utilizes more hand labor than either of the other types.

Further analysis of the dollar spent on highway work shows that in addition to the 45 cents paid directly to labor on the job, 46 cents is expended in wages and salaries by allied industries for the manufacture and transportation of materials, supplies, and equipment. This estimate is the same as that determined by the U.S. Bureau of Public Roads in a study of this problem.

In the exhibit a map of the state was included, on which was indicated the number of men given employment: first, in the upper peninsula; next, in the northern part of the lower peninsula; and last, in the southern or industrial section. The numbers were 14,000, 12,000, and 48,000, respectively, making a grand total of 74,000 men who were directly employed during the eight-month period as a result of this relief program.

Some interesting information, compiled from the unit

TABLE IV. REDUCTION IN COST PER MILE FOR VARIOUS TYPES OF MICHIGAN ROADS

TYPE OF WORK	YEAR					% REDUCTION IN COST
	1928	1929	1930	1931	1932	1928–1932
Grading and drainage	$18,200	$17,446	$14,326	$10,170	$8,373	53.9
Gravel road, complete	20,104	18,114	15,644	11,382	9,372	53.4
Concrete pavement, complete	36,921	34,450	30,820	24,136	19,863	46.3

TABLE V. MILEAGE OF ROAD CONSTRUCTION THAT ONE MILLION DOLLARS WOULD BUILD IN MICHIGAN

TYPE OF WORK	YEAR					PERCENTAGE OF INCREASE IN MILEAGE
	1928	1929	1930	1931	1932	1928–1932
Grading and drainage	55	57	70	98	119	116.3
Gravel road, complete	50	55	64	88	107	114.0
Concrete pavement, complete	27	29	32	41	50	85.2

Road building offers maximum relief for unemployment. Analysis of the expenditure of about $14,750,000 by the Michigan Highway Department shows that 45 per cent was paid directly to labor on the job and an additional 46 per cent to labor in allied industries. The percentage paid to labor on the work was highest—or 80 per cent—in the case of betterment work done under maintenance.

Reductions in the price of materials, supplies, equipment, labor, and other items have lowered the cost of road building. In Michigan the construction of a concrete pavement now costs the same as did the same mileage of gravel road five years ago.

Excluding Salt Water from Island Wells

A Theory of the Occurrence of Ground Water Based on Experience at Nassau, Bahama Islands

By J. ORMOND RIDDEL

ENGINEER IN CHARGE OF WATER DEVELOPMENT, NASSAU, ISLAND OF NEW PROVIDENCE, BAHAMA ISLANDS

AN engineering problem of peculiar importance in the West Indies is that of obtaining an ample domestic water supply. Ground water, which is replenished by copious rains, is the usual source, but because of the sponge-like structure of the underlying strata, overpumping causes infiltration of sea water and turns the water brackish. The theory here developed by Mr. Riddel is based on observation of many wells on the Island of New Providence, including experience in operating a battery of 90 wells at the Nassau Water Works. He develops a theory of the occurrence of ground water and explains the principles followed in the spacing and pumping of wells to secure the maximum amount of potable water.

UNDERGROUND sources of water supply are generally difficult to understand since the yield from wells or springs may vary in unaccountable ways. In particular, the water supply of Nassau presents many interesting features. The water works put in operation about four years ago by the Government of the Bahamas obtains its supply from an underground source some three or four miles south of Nassau on the southern slopes of the Baillou, or Blue, Hills (Fig. 1). The rock formation in New Providence consists of both Aeolian deposits and very hard and much weathered rock with large potholes on the surface and caverns underground. As a general rule where there are Aeolian deposits near sea level fresh water is to be found; and where the hard rock is near sea level salt water is to be found.

The Island of New Providence can be likened to an enormous sponge growing up from the bottom of the sea. Parts of this sponge are of very close texture—the Aeolian deposits—and parts are of open texture—the hard, weathered rock. The sea naturally penetrates through the "sponge" and as naturally rises and falls with the tides. At the Nassau Water Works the maximum tidal variation noted in an open well was 1.80 ft from low to high water, corresponding to a tidal variation in the harbor of 5.00 ft. It was found also that there was a lag, the amount of which was not determined, between high tide in the harbor and the corresponding change of level in the well. Moreover it was noted that a high wind on one side or other of the island would raise or lower the water level in the well.

Rain water eventually finds its way through the rock to the salt water level and, being lighter than the salt water, floats on it, either depressing the salt water or eventually becoming absorbed by it. If the rock is honeycombed the continual movement of the tides mixes the fresh and salt water, rendering the former unpotable. However, if the rock is of fine texture the fresh water will depress the salt water and float on top of it. Records show that at the source of supply for Nassau salt water is found at depths between 25 and 30 ft below the fresh water level, which latter is about at sea level.

The case of a well drilled down below the salt water level is illustrated in Fig. 2. Salt and fresh water are in intimate contact in the well, and the tidal fluctuations mix the two together. The mixture, being heavier than the surrounding fresh water, tends to spread through the rock in the form of a cone.

PROPORTION OF RAINFALL AVAILABLE

Provided no fresh water is taken from the area by pumping, the layer of fresh water should increase in depth every year. As apparently no large amount of water had ever been taken from the district until the water works was started, it might be concluded that at 25 or 30 ft below sea level the geology of the island changes, and that either underground caverns or honeycombed rock are to be found. This would be one explanation of the disappearance or dissipation of the

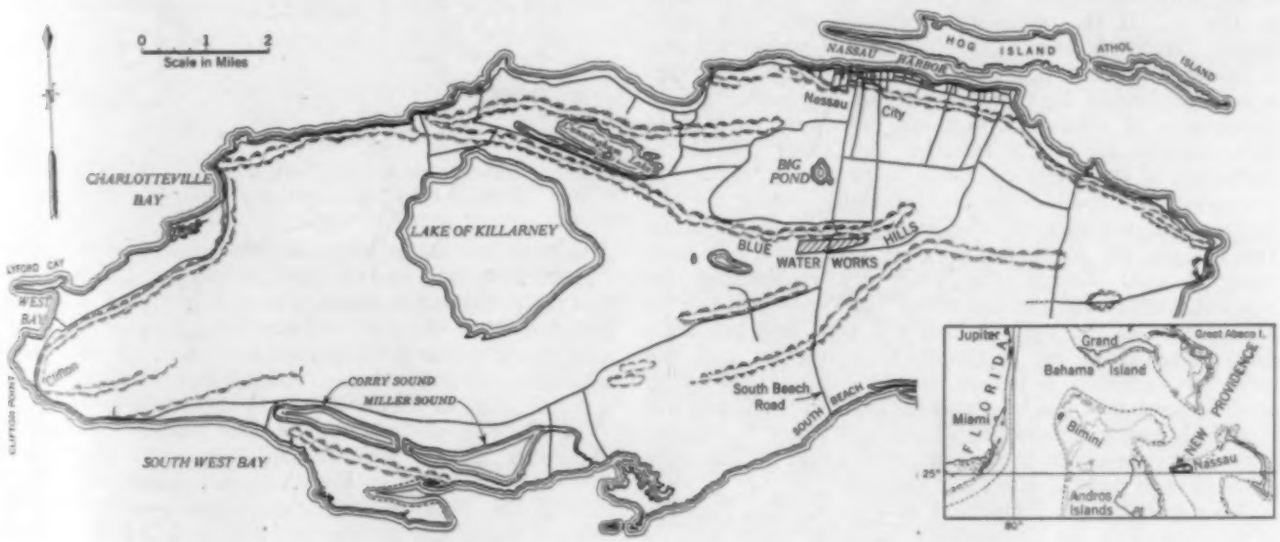


FIG. 1. ISLAND OF NEW PROVIDENCE, THE BAHAMAS

surplus rain water. But a much more likely explanation is that the lighter weight of the fresh water causes it to rise high enough above sea level so that it can run off, as indicated in Fig. 3. Water will not flow through porous rock from *B* to *A* unless the hydraulic head,

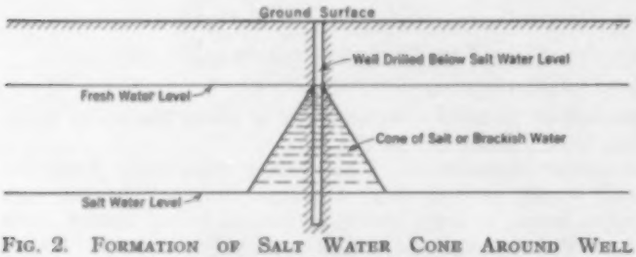


FIG. 2. FORMATION OF SALT WATER CONE AROUND WELL DRILLED BELOW SALT WATER LEVEL

BC, is high enough to overcome the frictional resistance of the rock. It is known that for a short time after a heavy rain the water in the Nassau wells is very much above its normal level. In other words, the height *BC* in Fig. 3 is sufficient to cause the surplus water to run off.

The only source of replenishment for the underground reservoir is rainfall, and the question arises as to what amount is absorbed by vegetation and what amount evaporates. Considering the subtropical climate, the site of the Nassau wells is none too thickly covered with vegetation, which grows mostly in potholes in the rock. A conservative estimate of the amount of rainfall that percolates through the rock, that is, the amount available for the wells, is $33^1/_3$ per cent of the total.

The area required for a water works of this type depends on the amount of water required and the annual rainfall. The average annual rainfall in New Providence is 45 in., according to records covering more than twenty years. If only one-third of the annual rainfall were available, the safe amount of water that could be obtained from an area 300 ft square would be approximately 2,900 gal per day. This shows that the average rate of pumping in the area during the whole year should not exceed 120 gal per hr.

GROUND-WATER LEVEL REMAINS THE SAME

A section through two such areas adjacent to each other, with one well in the center of each area, is shown in Fig. 4. If the wells were pumped day and night during the whole year at the rate of 120 gal per hr, and if rain fell day and night at the rate of 45 in. per year, a balance would be maintained—an impossible set of conditions, of course. Assuming, however, that there is a drought for a few months, the water balance is disturbed if the wells continue to be used. Since the ground-water level remains the same owing to the hydrostatic pressure of the sea, the sea water must rise to take the place of the fresh water that has been pumped out. Unless the wells are replenished by rainfall, eventually the apexes of the cones will rise to the bottom of the wells, which will turn first brackish, then salt. However, if pumping is stopped and the wells are allowed a period of rest, the difference in static pressure at the tops and bottoms of the cones will gradually cause the surface of the salt water to become level. It is essential to give the wells a rest periodically, even though there is abundant rainfall.

This principle is illustrated in Fig. 5. Let the line *ABC* represent an impervious layer of rock with a supply of fresh water on top of it. When water is pumped from the well the top surface of the water gradually assumes the form shown by the dotted line. If, however, the layer of rock, *ABC*, is replaced by a flexible layer of salt water, which is acted upon by the forces shown by arrows (in other words, the hydrostatic pressure exerted by the sea), it is easily seen that the surface *ABC* will take some form like that of a cone, as *ADC*.

In all the Nassau wells the fresh-water level remains constant during pumping except for the effect of tidal variations or an excessive rate of pumping. In the latter case, tests showed that the top surface recovered its original level within a few seconds after a pump was stopped.

PROPER SPACING OF WELLS IMPORTANT

Instead of one well in the center of each area pumping 120 gal per hr, as shown in Fig. 4, assume that there are 100 wells each pumping 1.2 gal per hr, as shown in Fig. 6. The total amount pumped from the area will be the same and will not exceed the annual replenishment from rainfall. It will be seen from Fig. 6 that a much larger amount of water can be pumped safely by this

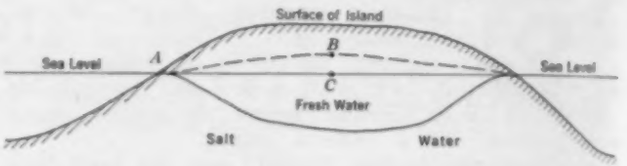


FIG. 3. LOCATION OF FRESH UNDERGROUND WATER IN AN ISLAND

method before the water in the wells turns salt, and the reservoir of fresh water below the wells can be drawn on to a larger extent.

At the main pumping station I drilled a well 19 ft deep located 300 ft away from the nearest well. After a month's pumping it began to turn brackish. An investigation showed that during the construction of the pumping plant a well within 20 ft of the new one had been sunk and pumped at a high rate day and night.

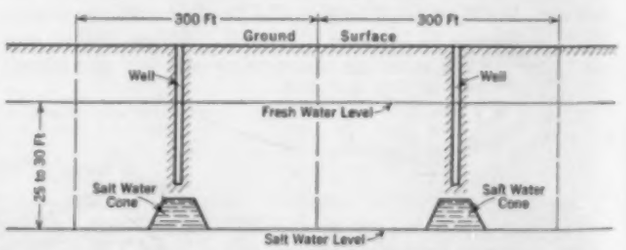


FIG. 4. SALT WATER CONES FORMING UNDER WELLS THAT DO NOT EXTEND DOWN TO SALT WATER LEVEL

A cone of salt water had undoubtedly formed under the construction well and had not subsided. The new well had penetrated this cone. To remedy the situation the bottom 9 ft of the new well was filled with cement grout and pumping was discontinued for a month. Since then excellent water has been obtained from the well during a period of more than a year.

It has been noticed that certain shallow wells in the Bahamas give salt water at high tide and fresh water at low tide. The reason for this phenomenon can be seen in Fig. 7. This diagram also explains the theory advanced as to the mixing of fresh and salt water in a cavity or in honeycombed rock.

Many local people have predicted disaster to the water works because wells of their own, which had been in use for one or two generations, suddenly turned salt. In every case investigated, however, it was found that these domestic wells went salt after electric pumps were installed. When water was lifted by hand the proper rate of pumping was not exceeded, but electric pumps, especially automatic ones, induced the owners to use more water than formerly, and the maximum permissible yield of the wells was exceeded.

The best proof of the theory of the recovery of the "static balance" of the wells is that, with one exception, none of the wells which were drilled over four years ago for the Nassau Water Works have shown signs of turning brackish. A record has been kept of the time each well has been pumped, and from this the total output can be calculated approximately.

From this study of ground-water conditions in New Providence the following general conclusions can be drawn:

1. The average hourly rate of pumping per square foot of surface of land is fixed by the rainfall and should not be exceeded.

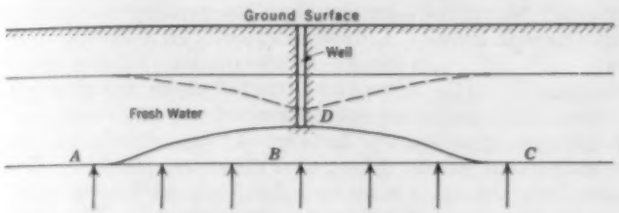


FIG. 5. SALT WATER RISING INTO A WELL ABOVE THE SALT WATER LEVEL

2. Within practical limits the average hourly rate of pumping per well depends on the spacing of the wells.

3. Provided that the first and second requirements just listed are complied with, the shorter the distance between the wells, the more water can be taken safely from the area during periods of drought without the water in the wells turning brackish or salt.

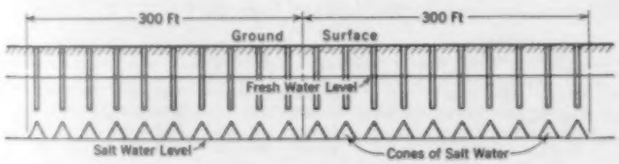


FIG. 6. EFFECT OF CLOSE SPACING OF WELLS ON YIELD OF FRESH WATER

In the battery of the Nassau Water Works there are 90 wells, spaced for the most part 300 ft apart and divided into 9 groups of 10 each. Fifty wells are pumped daily while the remaining 40 have a period of rest. Air-lift pumps are used, served by two air compressors, each having a capacity of 144 cu ft of free air per minute. Only one compressor is required; the other is kept as a standby. Each is run by a 20-hp electric motor direct-coupled or belt-driven by a 25-hp, single-cylinder, diesel engine, there being both an electric motor and an oil engine for each compressor. There are four collecting water mains with lateral branches, which convey the water by gravity to the two raw-water tanks. Each of these has a capacity of 108,000 gal. From them the water is pumped into two filters or softeners, where it passes through wood wool and is softened by the addition of lime and soda ash. The capacity of each filter is about 14,400 gal per hr. Usually both are in use at the same time.

There are three pumps, two of which have a capacity of 27,600 gal each and are run by direct-coupled electric

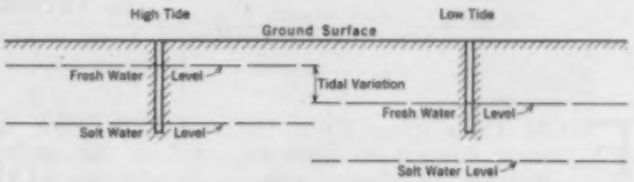


FIG. 7. EFFECT OF TIDES ON THE QUALITY OF WELL WATER
Levels of Fresh and Salt Ground-Water Rise and Fall with the Tides

motors of 11 hp. The third, which is only used in case the electric power fails, has a capacity of 14,400 gal per hr and is belt-driven by a 10-hp crude-oil engine. This latter will only serve one softener. From the softeners the water is discharged into two tanks each having a capacity of 108,000 gal. From these it is pumped to the main service reservoir in the City of Nassau through an 8-in. pipe, $3\frac{1}{2}$ miles long. The total pumping head, including friction, is about 210 ft. As the water is pumped, chlorine is introduced to the extent of 0.4 part per million. There are two main pumps, each of which has a capacity of about 38,200 gal per hr and is driven through gearing by a 60-hp electric motor (of which there are two) or belt driven by a 70-hp single-cylinder diesel engine (of which there are also two).

SAFE RATE OF PUMPING DETERMINED

The total area covered by the wells is 8,770,000 sq ft, including a strip 150 ft wide beyond the outside wells on each side. Taking the average annual rainfall as 45 in. and assuming that only one-third of this is available in the wells, the total annual consumption should not exceed, say, 96 mgd if the wells are to be kept from turning brackish. This means a maximum average hourly rate per well of 122 gal. Actually the rate of pumping at the Nassau Water Works is about 360 gal per hr. As the wells only work five weeks out of nine, the average output would be 200 gal per hr. This of course exceeds the allowable limit previously given, but there is a seasonal variation in the consumption. In January, February, and March, when many visitors come to Nassau, the consumption generally increases by 40 or 50 per cent. Therefore, during the rest of the year the wells have a daily rest of at least 8 hr in addition to their four weeks of complete rest. This would mean that the yearly output is roughly 100,000,000 gal, which is but slightly in excess of the amount theoretically available from rainfall.

The procedure followed is to keep a chart showing the monthly consumption of water as recorded by a master water meter at the main plant. This chart also shows one-third of the total rainfall over the whole area. When the rainfall curve falls so that it approaches, or drops below, the line of consumption, steps are taken to cut down the demand.

The conclusions here presented are based on the experience of over three years. It is hoped that they may serve as a basis for the accumulation of further knowledge in this field or at least may enable those faced with similar problems to avoid the pitfalls into which they might otherwise fall.

Discharge Through Tainter Gate Openings

A Record and Analysis of Observations Made at Dams on the Oswego River, New York

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NEW York State was a pioneer in the development and practical use of large-sized Tainter gates, many of which were installed on the Barge Canal. Since that time such gates have come more and more into general use, with a gradual increase in size, but records of discharge through them are still meager in technical literature. Observations made under Mr. Ripley's direction on openings in a dam on the Oswego River at Fulton, N.Y., in 1913, are here presented and analyzed for the first time. It is hoped that subsequently additional data on the subject will be made available through discussion.

FROM Three River Point the Oswego River flows north for a distance of about twenty miles to empty into Lake Ontario at the city of Oswego. In this section of the stream there are six dams: one at the village of Phoenix, three miles north of Three River Point; two at the city of Fulton, eight miles farther north; and three between this city and the lake at Oswego.

At Fulton, where the river banks are steep and high, the two dams are three-quarters of a mile apart. Above the upper one there is an eight-mile pool with much low-lying land on each side. Above the Phoenix Dam the pool extends up the Oneida and Seneca rivers several miles and into Onondaga Lake. All the land along this pool is but a few feet above the crest of the new dam. In planning the canalization of the Oswego River, one of the major problems was to keep down the cost of dredging and at the same time not to exceed the estimated flood damages due to raised pool levels.

In order to reduce the channel excavation in these two pools (Onondaga Lake is part of the canal system and is the Syracuse terminal), the old stone masonry dam at Fulton was raised by enclosing it in concrete, and a new concrete dam was built at Phoenix to a greater height than the existing one and at a new location. In each of these dams a set of six Tainter gates was constructed under my direction during 1913, and some measurements were taken of their discharge capacities. In Fig. 1, the details of the arrangement of the gates at Fulton are shown. The flow from the gates is on to a flat rock surface at practically the same elevation as the gate sill. The rock remains at this elevation for about 50 ft below the gates, where there is a vertical drop of 6 ft into the rapids.

The measurements for discharge capacity were conducted by young men who had had no previous experience in such work, and with equipment that was in part of crude, home-made manufacture. It is realized that the results are not sufficiently accurate to form the basis for a definite formula; nevertheless it is believed that they give a good general idea of the discharge capacity, and that they may be of some value as a guide for judgment in the design of similar structures.

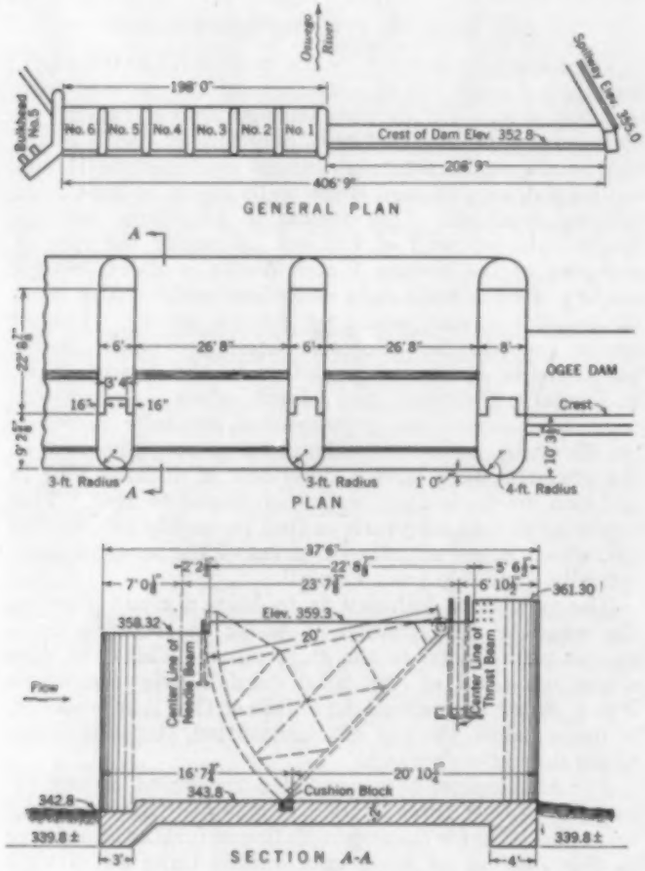


FIG. 1. TAINTER GATES AT FULTON, N.Y., ON THE OSWEGO RIVER
General Plan and Details

TABLE I. PITOT TUBE READINGS FOR A CONSTANT HEAD, *H*, OF 9 FT

Tainter Gate Opening No. 3 of the Dam at Fulton, N.Y. (Fig. 1)

Gate Travel on Rack and Floor In Ft	Vertical Distance Between Bottom of Gate In Ft	Depth of Minimum Section In Ft	Average Velocity Heads In Ft	Average Velocity Minimum Section In Ft per Sec	Area of Minimum Section In Sq Ft	Discharge *Q* In Cu Ft per Sec
1	0.77	0.58	8.3	23.2	15.5	360
2	1.38	1.07	7.6	21.7	28.5	620
3	2.10	1.60	7.0	20.8	42.7	890
4	2.85	2.23	6.3	20.0	59.5	1,200
5	3.65	2.90	5.3	18.4	77.3	1,425
6	4.46	3.67	4.3	16.8	97.9	1,650
7	5.38	4.55	3.5	14.4	111.4	1,604(?)
8	6.29	5.60	2.2	12.0	149.4	1,800(?)

VELOCITY MEASURED WITH PITOT TUBE

Among my old papers was found a letter signed by the young man who secured the velocity data by Pitot tube. In it he states, under date of June 21, 1913:

The instrument consisted of an iron tube 3 ft long and ¼ in. internal diameter, to which were attached six glass tubes of the same diameter and all together fastened on a 2 by 4-in. scantling, whose edges were well planed to "cut the water." The horizontal

tube was 5 in. long, also of iron and supported by a stiff iron brace that was nailed to the scantling. A double flange wheel on an iron shaft clamped to the truss work of the gate served as a guide for the scantling.

The results, which were obtained for one gate and only one section, are believed to be fair average values under which they were obtained, except the last two velocity heads.

No explanation is given in the letter for the remark about the last two velocity heads. No other gate openings in the dam were closed while the discharge measurements were being taken, and the pool level remained at the crest of the spillway, at a head of 9 ft on the gates. The velocity data for gate No. 3 of the Fulton Dam are given in Table I.

In Table II are shown the values of c as deduced from Table I by means of the theoretical equation, $Q = AV$, where Q is the discharge in cu ft per sec; A is the area of the section; and V equals $\sqrt{2gh}$.

The coefficient c, as found, follows the laws of discharge and gradually approaches a value of 0.62 for the opening in a thin edged plate until the last two values are reached. At this point it suddenly drops to 0.56, but even this change should not be considered as vitiating the value of the previous conclusion.

The last reading in Table I, that is, 8 ft on rack, was taken as turbulence began to show immediately below the gate, when the velocity of entrance was high and the water surface immediately above the gate was drawn down to such a point that air was carried under the gate.

From the design of the gates and their openings, it is seen that the issuing jet is neither that from a short tube nor any other form of jet covered in experimental models. The contraction of the lower side of the jet is fully suppressed, since the floor of the gate opening extends 13 ft 6 in. upstream from the cushion block or the gate sill and slopes down to the river bed a distance of 1 ft. The sides of the jet are also fully suppressed by the sides of the piers, and its upper surface is controlled by the curvature of the skin plate of the gate itself. The form of the upper surface of the jet varies from an orifice having an entrance angle of about 44 deg with the horizontal, for the smallest gate opening, to about 65 deg for the 8-ft opening, measured on the rack. In considering the physical conditions previously described, it is seen that the contraction of the jet is fully suppressed on three sides and partially suppressed on the top by the shape of the entrance.

From the meager data at hand, an effort has been made to compute discharges and compare them with the

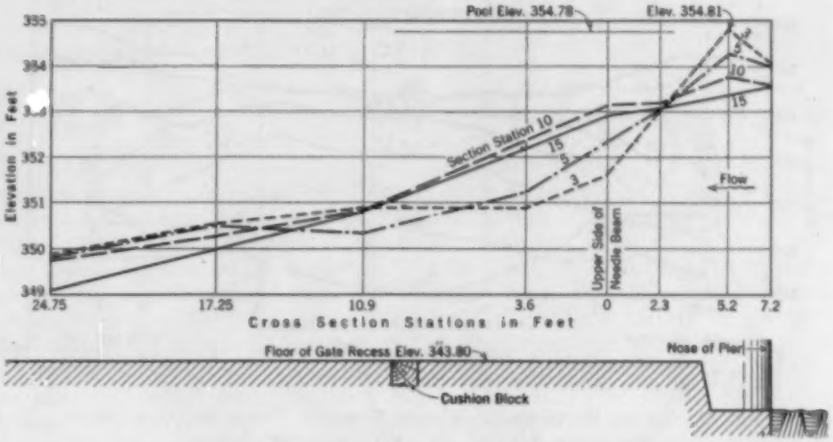


FIG. 2. WATER SURFACE ELEVATIONS OF FLOW THROUGH GATE NO. 3
Profile and Cross Sections for Full Gate Opening and a Head of 10.98 Ft

TABLE II. CALCULATIONS FROM TABLE I FOR THE VALUE OF c

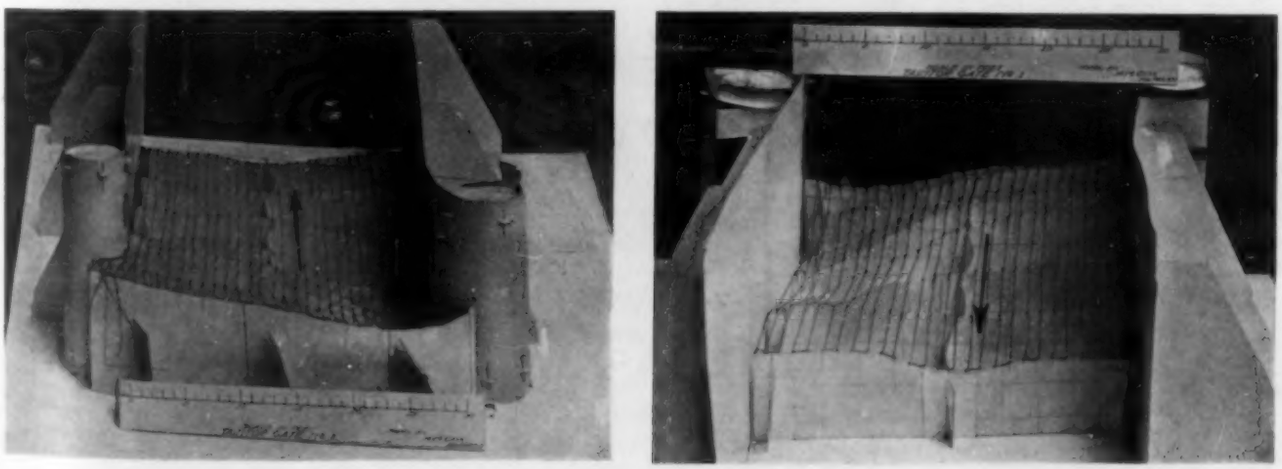
Travel on Rack In Ft	Vertical Height of Opening In Ft	Area of Opening A In Sq Ft	Head, h, at Center of Opening In Ft	Velocity V In Ft per Sec	Discharge $Q = AV$ In Cu Ft per Sec	Coefficient c, of Opening*
1	0.77	20.53	8.615	23.8	475	0.76
2	1.38	36.80	8.31	23.1	850	0.73
3	2.10	56.00	7.95	22.6	1,270	0.70
4	2.85	75.98	7.575	22.1	1,680	0.71
5	3.65	97.31	7.175	21.5	2,090	0.68
6	4.46	117.90	6.77	20.8	2,450	0.67
7	5.38	143.43	6.31	20.2	2,895	0.56
8	6.29	167.69	5.755	19.3	3,235	0.56

* c is obtained by dividing Q, in the last column of Table I, by $Q = AV$, above. The computations are made by slide rule.

TABLE III. THEORETICAL AND ACTUAL VELOCITIES COMPARED

Gate Opening In Ft	Theoretical Velocity $V = \sqrt{2gh}$*	Actual Velocity by Pitot Tube	Percentage of Actual to Theoretical
0.77	23.6	23.2	98.2
1.38	23.2	21.7	93.3
2.10	22.6	20.8	92.0
2.85	22.1	20.0	90.5
3.65	21.5	18.4	85.5
4.46	20.9	16.8	80.3

* $h = H$ (9.00 ft) minus 1/2 the gate opening.



MODEL OF FLOW THROUGH GATE NO. 1 FROM UPSTREAM (LEFT) AND DOWNSTREAM (RIGHT), AT A HEAD OF 10.98 FT

actual discharge through a fully opened gate. In Table III is given a comparison of the velocities found by the Pitot readings shown in Table I with the theoretical velocities, $V = \sqrt{2gh}$, of the partial gate openings, excluding the last two readings for reasons already given.

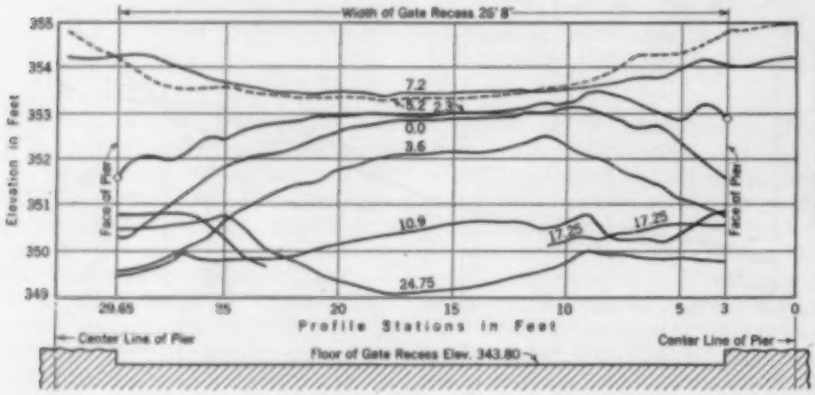


FIG. 3. CROSS SECTIONS OF WATER SURFACE THROUGH GATE NO. 3 With Full Gate Opening and a Head of 10.98 Ft.

As the full gate opening is approached, the results of the computations become more extravagant when compared with values determined by the orifice discharge formula. At full gate opening, Francis's formula, based on experiments in "a smooth rectangular channel, with section about 10 ft broad and 8 ft deep and a velocity of 4 ft per sec," must be abandoned in favor of the flat crested weir formula because the velocity of 4 ft per sec is too low for comparison.

In attempting to reconcile the flow through a gate with the experimental data for flat crested weirs it must be remembered that the experiments on which the formula is based were made under heads much less than those at the Fulton Dam. In fact, many experiments have been made with heads of less than 1 ft and few with heads as great as 5 ft.

On page 110 of Paper No. 150 of the U.S. Geological Survey, "Water Supply and Irrigation," by Robert E. Horton, M. Am. Soc. C.E., the coefficient C, in the formula $Q = CLH^{3/2}$ is given as 3.087. In "series 43" on the preceding pages, a value for C of 2.63 for a head of 1.2 ft is found. It is stated that the larger coefficients give a discharge "which is maximum for the conditions." Therefore, if the computation for discharge is based on the broad crested weir formula, C should be taken to have some value between 2.63 and 3.08. The value of C for the Tainter gate opening here under discussion must be left to the judgment of the individual engineer.

Solving the equation, $Q = CLH^{3/2}$, for a 9-ft head, it is found that the volume of flow is 1,766 cu ft per sec, by taking C as equal to 2.63 and with allowance for full end contractions; or 2,002 cu ft per sec, by taking C as equal to 2.78, and without allowance for end contractions. Since these contractions are not complete, because of the rounded pier ends, and since they are not entirely suppressed, as shown by the cross section, it is fair to assume one-half of the full end contractions. The results are 1,830 and 1,934 cu ft per sec. For a head of 10.98 ft, the same argument (one-half the full end contractions) gives 2,447 and 2,586 cu ft per sec. It should be noted that during the taking of measurements through gate opening No. 3, the other gates were closed. From an examination of Fig. 2 it is believed that the flow over the dam, at a depth of 1.98 ft, influenced the flow through the gate, the velocity of approach causing the draw-down shown on the dam side, that is, on the left side of the cross section. This effect did not exist while the measurements by pitot tube were being taken.

In building up the equation for flow over broad crested weirs, in Mr. Horton's paper, to which reference has been made, the velocity head is shown as the difference between the crest of the dam and pool level and the crest of the dam and the surface of flow after it has become parallel, or practically so, to the crest. At the Fulton Dam the water surface never became parallel to the floor of the gate recess before being discharged on to the flat rock surface of the river bed. Moreover, there is nothing in Paper No. 150 to show that turbulence existed during the experiments on which the equations are founded. That turbulence did exist within the gate recess at the Fulton Dam is amply proved by the cross section and profile shown in Figs. 2 and 3.

My appreciation is extended to H. M. Cox and E. Mercer Weiskotten, who assisted in the original work and to whom I am indebted for data in preparing this article. I am also indebted to Dwight B. La Du, M. Am. Soc. C.E., and to the late Frank M. Williams, M. Am. Soc. C.E., former State Engineers of New York, for information from which the drawings were prepared.

DAMS AT FULTON, N.Y.

At Left: Flow Conditions on June 15, 1922, at the Upper Dam, Shown in Fig. 1. Above: Upper Dam in Background, Above Bridge; Lower Dam and Pool in Foreground.

Photographs Courtesy of Ralph D. Hayes, Assoc. M. Am. Soc. C.E.

Flow and Percolation Studied Abroad

Current Experiments at the Hydraulic Institute of the Technical University of Berlin

By Donald P. Barnes

Junior American Society of Civil Engineers
Freeman Traveling Scholar of the Society, 1932–1933

ONE of the aims of the Freeman Scholars of the Society is to bring back news to American engineers of what European engineers are doing in the field of hydraulics. In this article Mr. Barnes describes several elaborate experiments now under way at the Hydraulic Institute in Charlottenburg that may prove useful in throwing light on difficult problems. He explains the equipment and procedure being used in the study of seepage and uplift under dams, the dragging force exerted against the interior walls of a pipe line by flowing water, and the movement of water through soils under various conditions.

SINCE the publication of *Wasserbaulaboratorien Europas*, by de Thierry and Matschoss in 1926, and its translation and amplification, *Hydraulic Laboratory Practice*, by the late John R. Freeman, Hon. M. Am. Soc. C.E., in 1929, great progress both in equipment and technic has been made by nearly all the European laboratories. At the Institut für Wasserbau of the Technical University of Berlin, at Charlottenburg, whose current experiments are the subject of this brief description, 13 bulletins have been published on subjects ranging from the hydraulic jump to the development of an electric field to serve as a fish screen for intake works.

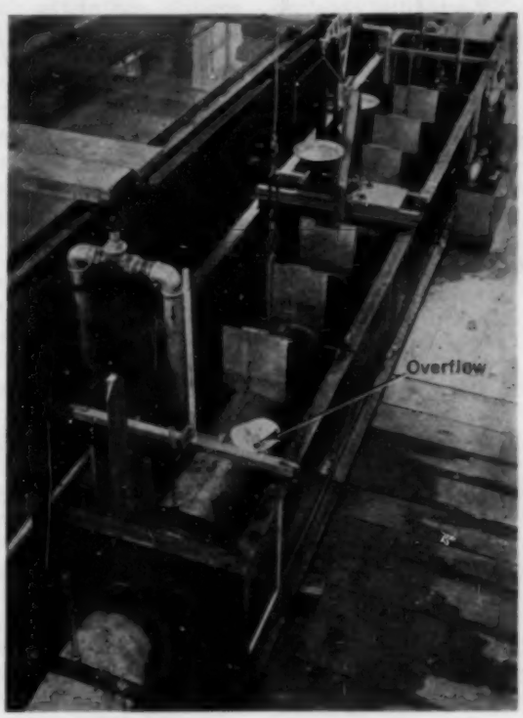
At present six separate researches are in progress under the leadership of Dr. Ing. Adolf Ludin, who took over the direction of the Charlottenburg laboratory in 1925. Of these, one is concerned with the distribution of pressure and percolation of water under weirs or dams protected by cut-off walls extending into the foundation soil; another is an investigation of the towing or dragging force exerted against the walls of a pipe line by flowing water; a third is a thorough study of the pressure and velocities at sharp-edged weirs set at different angles from the vertical; and three others concern the fields of irrigation and agricultural engineering and deal with soils and percolation.

PERCOLATION UNDER DAMS

In the past the effect of a cut-off wall on the seepage of water under dams and weirs has been the subject of some investigation, and very valuable experimental data have been obtained. The exhaustive research now being conducted by M. T. Ahmad as his doctor's thesis is an attempt to confirm the existence of a general law or of an analogy that will enable the prediction with considerable accuracy of uplift pressures in any given foundation material. The major part of the investigation consists of measuring pressures at 62 points in the saturated material beneath the skeleton model of a dam.

A box, approximately 10 ft high, 26 ft long, and 2 ft 3 in. wide, was built of wood and lined with galvanized sheet metal to ensure against leakage. It was filled to a depth of 5 ft 9 in. with coarse sand having grains about 2 mm in size. This sand constitutes the foundation on which rests the steel plate representing the bottom of the dam (Fig. 1). Two vertical steel plates form the upstream and downstream cut-off walls, and a third, projecting upward, forms the dam itself. The plates are carefully sealed to each other and to the metal lining of the box with a packing of lead wool and a coat of a hot bituminous mixture. The two cut-off plates are unbolted, raised or lowered, and resealed as the experiment requires.

The test program calls for observation of the pressures registered by each of the piezometer tubes at least once for every practicable combination of cut-off wall depths and difference between reservoir and tailwater elevations. The cut-off walls are placed at depths below the ground surface of zero, 5.9, 21.7, 37.4, and 53.1 in.; the upstream water surface is maintained at elevations of 7.9, 23.6, and 39.4 in. above the surface of the sand; and the downstream water surface is kept at elevations of 1.8, 13.0, and 24.8 in. above the sand. This procedure requires a series of 136 sets of readings, for each of which the flow of water through the sand must reach equilibrium. Constant reservoir and tailwater heads are secured through the use of two siphons 2 in. in diameter, with adjustable discharge elevations. A uniform inflow of water is assured through the use of a surge pipe, which damps out minor pressure fluctuations in the city water mains and permits the escape of entrained air. To provide control of the quantity of water passing through the apparatus, a triangular weir is used at the discharge end. The inflow can be measured with a venturi meter, and the discharge of the siphons can be measured by timing the flow into a small container, so that a check against equilibrium, leakage, and accuracy of weir measurements is obtainable.

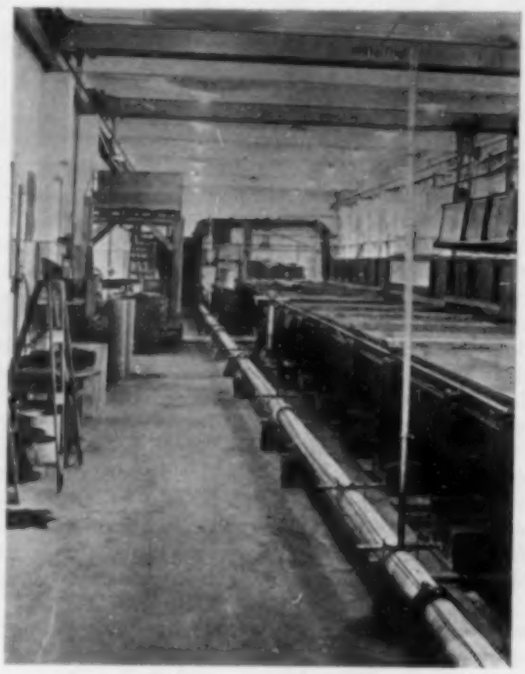


Laboratory Setting of Tests on Hydraulic "Drag" in Pipes

Contours of pressure are being plotted for each of the conditions studied. Those already completed verify the accuracy of the work and give promise of

some new and valuable conceptions regarding ground-water action.

As supplementary to the work on water pressures, an experiment is being carried out to determine the properties of stream lines and one to determine the nature of an electric field about an obstacle of proportions exactly similar to those of the dam cut-off walls. If it should appear either that the stream lines are similar to the contours of pressure under the dam or that the potential drop in an electric field corresponds to the pressure drop under the dam, an analogy will have been developed that should be capable of extensive application to dam design.



INTERIOR VIEW OF THE LABORATORY
Technical University of Berlin, at Charlottenburg

DRAGGING FORCE IN PIPES

The study of the "drag" in pipes being conducted by Professor Ludin represents a new approach to the experimental determination of head losses. Briefly, the apparatus used (Fig. 2) consists of a piece of asbestos cement pipe 13 ft long and 7.8 in. in diameter, suspended, in the form of a ballistic pendulum, as a continuation of a longer reach of straight pipe. The suspended section is connected directly to specially constructed scales so that the horizontal force of the water in the direction of flow may be accurately measured. A clearance of about a quarter of an inch at the free ends of the pipe permits the necessary freedom of movement. Readings are being taken on flows varying approximately from 0.12 to 1.42 cu ft per sec, or at velocities of 1.20 to 13.93 ft per sec.

An interesting feature of the apparatus is that it provides against discharge at the open joints. The entire free length of pipe is submerged in a small tank about 19 in. deep, 14 ft long, and 19 in. wide. Between the two pipe joints are seven partitions dividing the tank into eight compartments. In the first and last of these the water levels are kept at exactly the heights required to hold the internal water pressures of the conduit in equilibrium. The internal water pressure at the open joint itself is assumed to be the average of the pressures shown by two manometers, one in the fixed, and one in the free end. Since the partitions may not touch the suspended pipe at any point, there is a flow of water from the upstream to the downstream compartments through the small peripheral clearances of roughly $\frac{1}{4}$ in. The flow is maintained by a separate 2-in. supply pipe connected to the upper compartment, and by a 2-in. siphon with an adjustable discharge elevation at the lower compartment. This apparatus can be seen in a photograph.

The water supply is obtained from a constant-head reservoir, which is part of the permanent equipment. A gate valve at the head of the cement pipe line is used to vary the flow, and a venturi meter behind this provides for the velocity measurements. Immediately outside the submerging tank and 19.7 in. both upstream and downstream are piezometer tubes which, together with a pair at the extreme ends of the long pipe line, constitute the control and check on velocity and head losses. Most of the runs have already been completed, and the method appears to be practicable.

The purposes of the research on sharp-edged weirs are to make an exact determination of the discharge coefficients at angles of inclination varying from 36 deg from the vertical upstream to almost 90 deg from the vertical downstream, and to explore the behavior of the stream lines in the immediate approach and at the nappe. A brass weir plate has been installed in a channel 19.7 in. wide and 13 ft long in such a way that its lower edge lies accurately in the plane of the channel bottom. At the end containing the weir, which is suppressed, the channel walls are of glass for a distance of 5 ft 9 in. In order that air may be freely admitted behind the crest, the channel floor is discontinuous at the weir so that the water falls freely into a second channel underneath the first. In a photograph of the interior of the laboratory the upper channel may be seen being swung into position at the right.

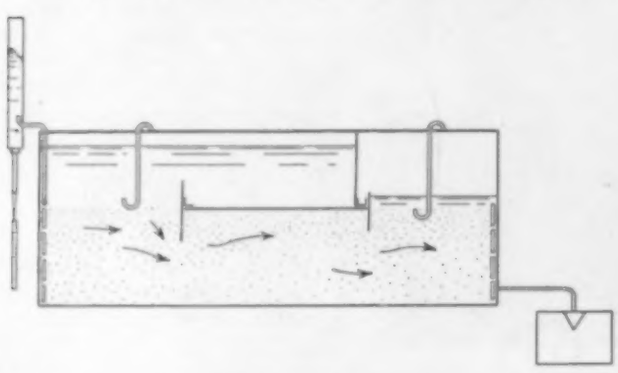


FIG. 1. APPARATUS FOR STUDYING PERCOLATION AND PRESSURES UNDER DAMS WITH CUT-OFF WALLS

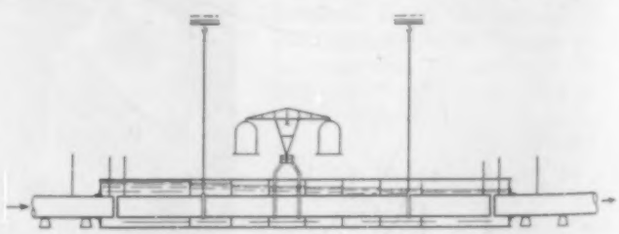


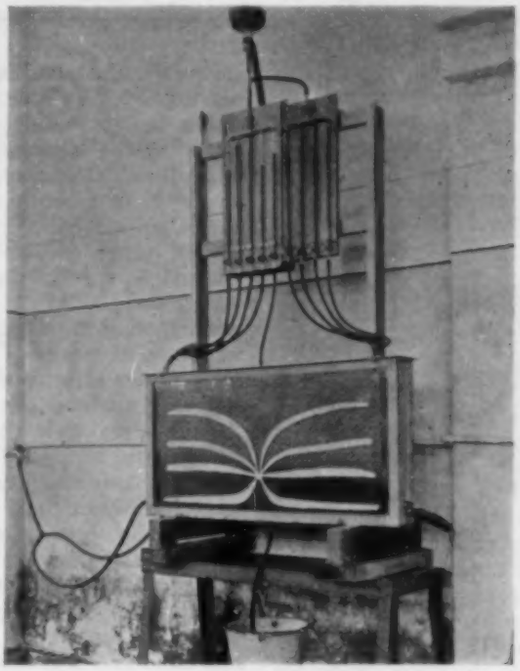
FIG. 2. BALLISTIC PENDULUM EQUIPMENT FOR MEASURING THE "DRAG" IN PIPES

In order to establish the elevations of the water surface, a point gage was mounted on brass rails above the channel. These rails, which provide for the movement of the gage in a longitudinal direction, have been carefully leveled by comparison with the still-water surface. The discharges, which are varied between 0.035 and 1.060 cu ft per sec, are measured with a previously cali-

brated triangular weir placed at the extreme end of the lower channel. Both a point gage and a sensitive recording gage ensure that the surface elevations at this weir are accurately determined.

In the second phase of this experiment, a short length of fine thread is attached to the end of a metal rod and projected into the current. The direction assumed by the thread under the influence of the current is determined by inclining the rod until an offset constructed on it perpendicular to its length lies parallel to the thread. The angle from the vertical is then read on a clinometer attached to the upper end of the rod. Simultaneously with these observations, readings of a pitometer are taken at the same points as the directional measurements. This study is not being conducted for all inclinations of the weir, but in each case enough points are taken at the nappe and a few inches upstream from it to secure a cross section through the stream lines and their velocities.

One of the accompanying photographs shows a percolation box constructed by Professor Ludin, in which the directional movement of water toward a drain or open cut may be observed and analyzed. The box is about 3 ft long by 1½ ft high and 4 in. wide. It is filled with fine sand, to which water is admitted through perforations distributed vertically at both ends. The drain is located at the center, near the bottom. The dye reservoir is just visible at the top of the picture. To it are connected nine glass tubes, which are used somewhat after the manner of pipettes to control the quantities of coloring admitted with the water. The white stripes painted on the glass side of the box emphasize the darker stains left by the dye in its typical course toward the central drain.



ILLUSTRATING THE MOVEMENT OF GROUND WATER TOWARD A DRAIN

PERMEABILITY OF SOILS STUDIED

In an exhaustive series of investigations, Professor Oehler, Assistant Director of the Institut für Wasserbau, is determining the velocity of penetration, the discharge, and the capillary rise in sands and organic soils in varying states of saturation. Three soils may be studied simultaneously in the three sheet-metal boxes he is using in the investigation, each of which is 2 ft square by 5 ft 10 in. high. At vertical intervals of about 10 in., piezometer tubes are placed in the centers of the samples and connected through the walls to manometers ranged outside the boxes. The efflux from the drains, which are placed 1½ in. from the bottom of the boxes, is caught in small containers and measured at appropriate intervals.

Each soil is tested in three ways. First, a light "rain" of from 0.8 to 4.1 in. is allowed to fall on the surface, and the time required for the moisture to reach the drain and to be discharged through it is carefully observed. Temperature has been found to be an important factor. A rise of a few degrees in the daily average has caused the time lapse between the "rain" and the discharge to be shortened from weeks to days. In addition, pressures developed at the two lowest piezometers are measured.

Water is next forced in at the bottom until it appears at the surface and reaches a stipulated depth of from 1.2 to 5.5 in. This is done to ensure the expulsion of air and consequent uniform saturation. Water is then supplied at the top, the depth of water on the soil being held constant, while the discharge and pressure distribution throughout are measured. Finally, the water surface is allowed to drop through the material until no further discharge is observed. During this last stage, which in some instances has required longer than a month, all manometers are periodically checked. Interesting results have already been noted, showing suctions of as much as 12.3 in. (measured on the manometer) caused by capillary action. As a check on the results, and in order to make the progress of the water visible, glass tubes 1.2 in. in diameter have been filled with similar soils and treated in the same way and at the same time as the cubes in the metal boxes.

A parallel investigation is being conducted on samples in a glass tube 2.0 in. in diameter and 4 ft 5 in. long. This tube is equipped with six piezometer outlets, by means of which studies similar to those made in the larger containers are conducted with the added advantage of visibility. In addition, this apparatus is being used to investigate the effects of capillary movement from sub-irrigation as simulated by the immersion of the bottom of the tube in water, and the gravitational and capillary movement of water from the surface.

A separate experiment is being conducted to investigate the permeability of small cubical samples of soil in an undisturbed state, in directions parallel as well as perpendicular to the surface. The earth to be tested is cut into 6-in. cubes, which are placed in sheet-metal boxes slightly larger than the cubes. The cubes are laid either with the original surface up, as in nature, or on edge. The clearance around the soil is then filled with paraffin and a known quantity of water is poured over the top. The amount that seeps through holes in the bottoms of the boxes into small measuring cans is recorded hourly or daily until the flow stops. When the study is completed a comparison will have been made between the horizontal and vertical permeability of 16 types of soils.

In addition to these percolation studies, Professors Ludin and Oehler are conducting a series of analyses to determine the grain sizes of soils. One of these studies involves the investigation of an apparatus using centrifugal force for the precipitation of soil particles in solution.

The results of all these researches will probably be available in German by the end of this summer. Other experiments of great interest to hydraulic engineers are already being contemplated. It is to be hoped that the results of all of them will sooner or later be available to engineers in the United States.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

New Pivots and Bearings for Small Current Meters

By R. L. Atkinson

Chief, Division of Field Equipment, U.S. Geological Survey, Washington, D.C.

FOR many years the U.S. Geological Survey has been experimenting to find a steel alloy that would retain its shape and hardness in the pivots and pivot bearings of the small Price current meter (Fig. 1), the standard current meter of the Survey. Since the pivot and its bearing play a very important part in the operation of the meter, great care must be exercised in hardening and tempering the bearing surfaces. In the past the point of the pivot was ground to a radius of 0.005 in. before the meter was rated by the U.S. Bureau of Standards. It was usual to have a point radius of 0.01 in. on completion of such rating. Examination of meters that had seen considerable service in the field showed that this radius increased, owing to wear under average working conditions, to as much as 0.03 in. Spin tests in air with the pivot in this condition have shown an apparent decrease in sensitivity of more than 80 per cent. The spin test consists in bringing the meter cups to a constant speed in the draft from an electric fan. Then the fan is shut off and the length of time required for the cups to cease revolving is recorded. A standard meter, well adjusted, will spin slightly over three minutes.

With the new steel alloys it has been found possible to grind the point of the pivot to an initial radius of 0.01 in., which changes but little with extended field use. The sensitiveness of the meter has also been increased, for repeat ratings have been found to be quite consistent with the original one.

Before starting the production of these parts, the U.S. Geological Survey made a quantitative study of the nature of the wear of the bearing surfaces. The variable factors in this study were the choice and design of materials, the conditions under which the pivot and its bearing were operated, and the element of time. The conditions of field operation could be closely approximated in the laboratory, but the time factor presented difficulties. The method finally evolved was to place on the pivot a heavy circular metal disk, the equivalent of a load of 90 tons per sq in. on the bearing surfaces, or 106 times the normal load. The pivot was then allowed to spin in its bearing, which was immersed in water, for 46 hr. At frequent intervals the pivot and bearing were removed, placed in a meter (the same one was used throughout the test), and subjected to spin tests under strictly comparable conditions. This procedure corresponded to thousands of hours of usage under normal field conditions, and was found to serve three useful purposes, as follows:

1. It demonstrated that a newly ground pivot will wear rapidly at first, the rate decreasing with use until practically no wear is apparent, as shown in Fig. 2. Therefore the pivot should not be given too sharp a point, except possibly for measuring sluggish streams that are free of silt.
2. The useful life of pivots and their bearings was indicated in a short period of time.
3. It provided a quick and dependable method for comparative studies of different types of steel and made it possible to find the optimum degree of hardness and brittleness for pivots and their seats

The materials and elements of design finally adopted were decided upon largely from the results obtained by these ultra-severe tests. A steel alloy, designated A-Metal, containing the following elements, has proved the best suited for the making of pivots and their bearings: 0.95 per cent carbon, 0.275 silicon, 1.07 manganese, 0.54 chromium, 0.16 vanadium, and 0.64 tungsten.

The heat treating is done in a gas furnace, where the pivot is brought slowly to a temperature of 1,450 F, at which it is allowed to soak. It is then quenched in oil for 0.1875 in. from the point. This gives a Rockwell hardness of C-58 within 0.125 in. of the point. Next, the pivot is reground to eliminate any warping that may have taken place during the heating operation. Great care must be taken in grinding and polishing the point to reduce the heat of friction to a minimum.

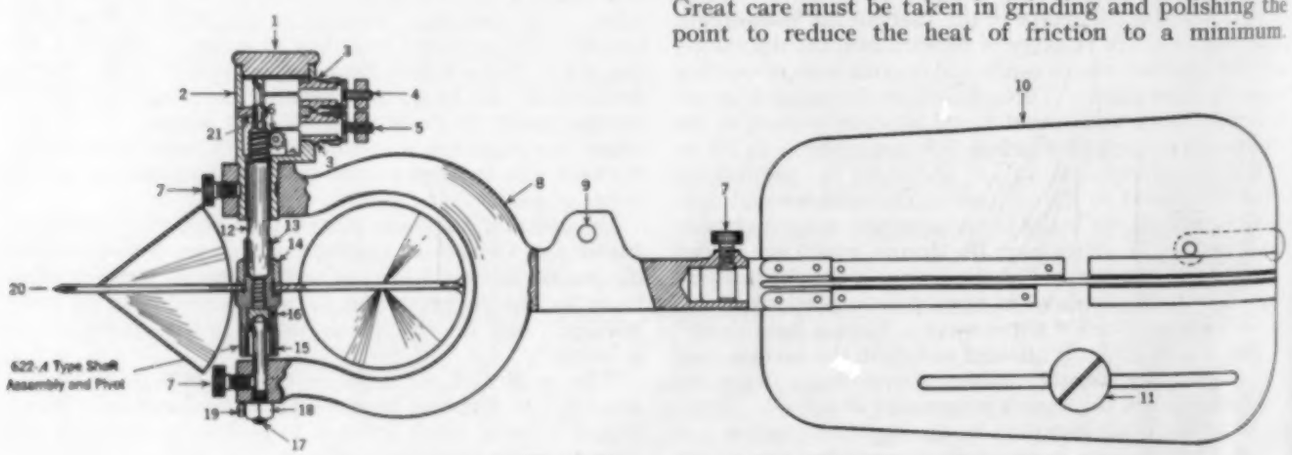


Fig. 1. Small Price Current Meter with Improved Pivot and Bearing
622-A Type of Assembly

Otherwise the bearing surface, approximately 0.010 in., might become annealed.

The pivot bearing or seat, 0.3125 by 0.3125 in., is drilled to a diameter of 0.201 in. and a depth of 0.1875 in. The bottom of this seat, after hardening, is ground to a diameter of 0.205 in., an angle of 105 deg at the bottom, and a radius of 0.025 in. at the apex. In heat treating, the pivot seat is heated slowly to 1,575 F and allowed to soak until the whole bearing has a uniform temperature. The tongs used to remove the seat from the furnace are heated to the same temperature so as to prevent cooling of the bearing between furnace and quench bath. When the seat is quenched in oil, care is taken to hold it upright lest the liquid fail to reach the bearing surface. The quench bath is immersed in a tank of running water so that its temperature remains low. After removal from the bath the parts are tested for hardness. Any seats having a Rockwell hardness under C-60 are rejected. The accepted seats are then placed in the lapping machine, where the final polishing is done.

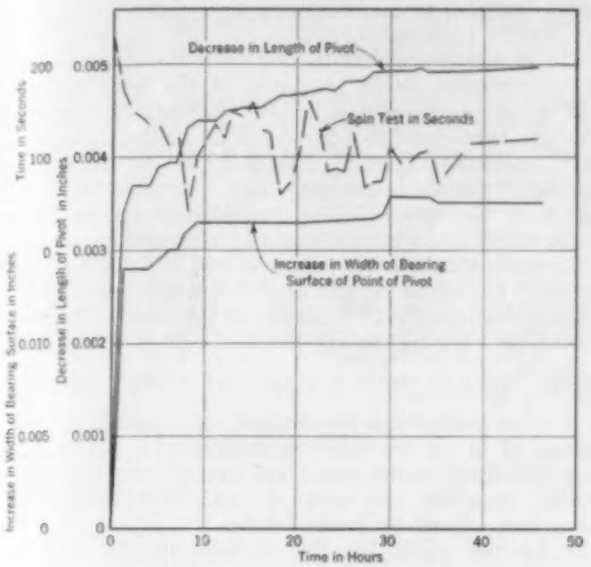


FIG. 2. RESULTS OF TEST RUN FOR 46 HR (414,000 REVOLUTIONS) Pivot of A-Metal, of C-58 Hardness, and a Radius of 0.005 In.; Bearing of A-Metal, of C-61 Hardness. Pivot and Bearing Were Inspected and Measured Every Hour During Test

Like the pivot, the bearing is given a glass-smooth finish, and the heat from friction is reduced to a minimum. The sides as well as the apex of the pivot seat are polished, because at high velocity the bearing assembly is lifted off the pivot but the sides of the bearing remain in contact with the sides of the pivot. The pivot bearing then acts as a simple cylindrical bearing. In every lot of bearings several are broken in half so that a hardness reading can be taken just above the apex of the bearing surface. This reading must be the same as that on the outside surface.

Experiments were also made with case-hardened pivots and bearings, that is, those hardened by cyanide compounds or nitride. Three objections to case-hardening were found. First, there is the mechanical difficulty of protecting from the effects of the process the threads and surface where the set-screw bears. Such surfaces must be covered with clay, a slow and costly operation, which at best is not dependable. Second, case-hardening, like any other hardening process, causes distortion, but grinding cannot be resorted to because it removes the hardened surfaces. Third, either this original grinding, to remedy distortion, or the subsequent grinding by silt-laden water, will remove the hardened surfaces. When wear has penetrated to the base metal, the least shock will cause a case-hardened surface to crack or flake off. In shaking the water out of a meter it will often be swung up and down, and even this movement will cause flaking. The bearing surface is so small that a very slight fracture will slow up the meter. The pivot bearing is unlike a ball bearing or cylindrical bearing in which the bearing surfaces constantly change. For these reasons, case-hardening was rejected as impracticable.

For the pivots and pivot bearings of these Price meters, I have recently utilized the steel alloys for which the formula has been given, after proper hardening, as here described. As a result there has been a distinct increase in the length of service of meters, and their ratings for low velocities have improved. Extended laboratory tests have shown that the frictional resistance in the meters has been decreased to such an extent that the spin test in air shows very consistent results, even after long use.

The Reynolds Number

By ROBINS FLEMING
CONSULTING ENGINEER, NEW YORK, N.Y.

IN their monographs, "Wind Stresses on Structures" (Scientific Paper No. 523 of the U.S. Bureau of Standards) and "Wind Pressure on a Model of a Mill Building" (Research Paper No. 301 of the U.S. Bureau of Standards), Hugh L. Dryden and George C. Hill refer to the Reynolds number. It is mentioned in many books on physics and usually in books on hydraulics. Stanley Dunkerley, who succeeded Reynolds in a professorship, entitles a chapter of his *Hydraulics*, "Professor Osborne Reynolds' Researches." Also the Reynolds number is given a prominent place in books on aerodynamics. However, it seems to be but little known to structural engineers and is not mentioned in books on structural engineering. An explanation of it therefore may not be out of place.

Osborne Reynolds (1842–1912), a noted English physicist of the last century, was Professor of Civil Engineering at Owens College, Manchester, for nearly forty years. In the announcement of his death, *Engineering* (London) for February 23, 1912, says, "On the scientific side of engineering he occupies a very high position and, like Rankine, he suffered from an indisposition to make his researches easily intelligible to practical men." Of his many scientific papers, the one by which he is best known is "An Experimental Investigation of the Circumstances Which Determine Whether the Motions of Water Shall Be Direct or Sinuous, and of the Law of Resistance in Parallel Channels," published in the *Philosophical Transactions* of the Royal Society, Vol. 174, 1883; also in Vol. 2, pages 51–105, of Reynolds' *Papers on Mechanical and Physical Subjects*.

The theory of hydrodynamics did not explain, among other things, why the resistance to the flow of water in tubes of small diameter was proportional to the first power of the velocity, while in large tubes and pipes it varied nearly as the second power. Reynolds set about investigating this phenomenon, with far-reaching results affecting fields undreamed of in his day. By introducing colored filaments into water flowing through glass tubes,

he showed that at low velocities the flow was in straight lines parallel to the tube axis, while at higher velocities it was turbulent and full of eddies. The point at which one type of flow changes into the other he called the "critical velocity." He found both a "low" and a "high" critical point. For velocities below the low critical point the loss of head was proportional to the first power of the velocity; for velocities above the high critical point this loss was nearly proportional to the square of the velocity, depending somewhat on the frictional resistance of the internal surface of the pipe.

Reynolds showed that the variables affecting the flow of a fluid in a cylindrical tube are measured by a ratio that is a pure number, that is, $\frac{VD\rho}{\mu}$, in which V is mean velocity of flow; D, diameter of the tube; ρ, density of the fluid; and μ, its viscosity. As ρ and μ are both properties of the fluid, it is convenient to denote the ratio $\frac{\mu}{\rho}$ by a single term, η, known as the kinematic viscosity. To make the expression more general, D is replaced by L, the linear dimension normal to the direction of flow, or the ratio becomes $\frac{LV}{\eta}$. The expression $\frac{LV}{\eta}$ is called the Reynolds number. It is the ratio of the forces of inertia to the forces of viscosity. The forces of inertia are increased proportionally to $L^2V^2\rho$, and the forces of viscosity proportionally to $LV\mu$. If they both increase in the same ratio, $L^2V^2\rho$ equals $LV\mu$, and $\frac{L^2V^2\rho}{LV\mu}$ equals $\frac{LV}{\eta}$ and remains constant. Different combinations of scale, velocity, and fluid give the same coefficient if the Reynolds number is the same.

As aptly stated by Max M. Munk in his recent book, *Fundamentals of Fluid Dynamics for Aircraft Designers*, "A single Reynolds number standing alone, together with the definition of the characteristic velocity and length, is only an identification number, not much more than the street number of a house." The Reynolds parameter is a more appropriate name.

Velocities of fluids occurring in common practice are usually turbulent and far above the critical point. However, the flow of oil through pipe lines is non-turbulent, owing to the viscosity of the oil.

APPLICATION TO MODEL EXPERIMENTATION

It should be noted that in applying data drawn from experiments with a model to its prototype, the two should have both dimensional homogeneity and dynamic similarity. In using models to investigate friction as it affects the flow of fluids in pipes, the model will exactly represent its prototype if both have the same Reynolds number and exactly similar internal surfaces. For example, if the water in a model is at the same temperature as in the full-sized construction, and if the model is one-tenth the size of the prototype, then the velocity in the model must be ten times that in the full-sized pipe if the result is to be correct.

If the only physical factor involved is the weight of the fluid (viscosity or friction ignored and only the forces of inertia considered) and if the scale of the model is $\frac{1}{n}$ for dynamic similarity (the same pressure per square foot) the speed of the model must be $\frac{1}{\sqrt{n}}$ that of its prototype. Thus if water is flowing at 10 ft per sec in the prototype, the speed must be $\frac{1}{10\sqrt{n}}$ in the model.

The viscosity, μ, of gases is much smaller than that of liquids but it is not always negligible. The coefficient of the kinematic viscosity of air is usually given in the centimeter-gram-second system, but it may be expressed in any other system. Assuming it to be 0.000161 ft² per sec, the Reynolds number is equal to the product of the wind speed, V, in miles per hour, by the length (normal to direction of wind) of the body, L, in feet, by the constant 9,110.

The resistance offered by the viscosity of air is based on experimental data. A model of the body is placed in a wind tunnel and subjected to varying velocities. This has been done to a great extent in the endeavor to solve problems of flight. It is found by experiment that aerodynamic forces vary only approximately as the square of the speed. This variation is known as the "scale effect." It cannot always be ignored.

To eliminate scale effect, model and body should have the same Reynolds number. It is usually impracticable to make the speed vary inversely as the scale of the linear dimension. Owing to its density, the kinematic viscosity, $\frac{\mu}{\rho}$ or η, of water is about one-twelfth that of air. If it were practicable to conduct experiments in water instead of in air the scale of the model could be 1:12, or a full-sized model could be run at one-twelfth the speed. However, the value of η can be reduced by the use of compressed air in the tunnel.

At Langley Field, Va., the variable density wind tunnel of the National Advisory Committee for Aeronautics can be operated with a pressure of 20 atmospheres. The tunnel motor is 250 hp. The scale of L can thus be reduced twenty-fold, or tests can be made on a $\frac{1}{10}$ scale model at one-half the speed. The resultant model pressure is $20(1/2)^2$, five times the actual pressure.

In his book, *Aerodynamics*, Edward P. Warner states: "The only completely and finally satisfactory means of determining scale effect is a direct comparison between a model test and a free flight measurement on the full-sized machine. Where that is impossible, the next best thing is a wind tunnel test at a very high Reynolds number, the higher, the better."

A wind tunnel has now been built in which an average full-sized machine can be tested. The giant wind tunnel at Langley Field, Va., of the National Advisory Committee for Aeronautics, costing over a million dollars, was dedicated on May 27, 1931. Designed to accommodate spans of 45 to 60 ft, it is 60 by 30 ft at the throat.

As far as most buildings are concerned, the Reynolds number is largely academic. At the velocity of wind for which they are designed, the tangential forces due to viscosity are negligible. According to Dryden and Hill, bodies with flat surfaces and sharp edges show no scale effect, or small scale effects. The velocity pressure on any side of a building from a wind normal to the surface is $P_v = \frac{1}{2}\rho A V^2$, in which A is the area of the surface. The total pressure may be written $P = K\left(\frac{1}{2}\rho V A^2\right)$, in which K is a constant, or coefficient, depending for its value on the shape of the building and its "attitude," that is, the inclination of its side with respect to the direction of the wind. In "Wind Pressures on Structures," Dryden and Hill state: "For spheres and cylinders the variation is very great, and certain critical regions of Reynolds number occur in which the coefficient decreases very rapidly. In these cases it is difficult to predict the average pressure on the full-scale structure from the model."

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Bridge Portal Can Support Load Without Top Chord

DEAR SIR: The discussion of "Portal Effect on Top-Chord Stresses," by B. J. Lambert, in the June issue, is welcome. The portal serves as a rigid frame with a horizontal force acting on it at the top panel point. Its reactions are in the plane of the portal. When the portal is in an inclined position, as it is in Mr. Lambert's Fig. 1 (*a*), these reactions are resisted by component forces consisting of vertical shoe reactions and horizontal stresses in the bottom chords.

When the portal is in a vertical position, the portal reactions go directly to the truss shoes without stressing the bottom chords. From the analogy of the rigid frame it is evident that the portal will support its load without the assistance of the top chord.

HAROLD D. HUSSEY, Assoc. M. Am. Soc. C.E.
Designing Engineer, American Bridge Company

New York, N.Y.
June 7, 1933

Author Comments on Stirrups and Deflections

TO THE EDITOR: The comments received on my papers, "Deflection in Reinforced Concrete Beams" and "Stirrups for Reinforced Concrete Beams," published in the October 1932 and January 1933 issues, respectively, are appreciated.

In reply to Mr. Bertin's letter, in the March number, I purposely restricted the application of the method for the design and spacing of stirrups to the simplest kinds of loads and beams in order to emphasize a principle or method of attack, unencumbered by involved and complicated loads or restrained end conditions. For such principle or method, when once understood, can be readily applied by any designer to the types of loads and beams enumerated by Mr. Bertin.

In reference to the treatment of Case 2, as Mr. Bertin notes, the maximum values given for the end and center shears that occur under moving loads cannot occur simultaneously at these two points. Nevertheless, the method of treatment as outlined is both practical and simple, and the slight error that has been made in the assumption is on the conservative side. Without some such assumption, the problem cannot be readily solved. I wish to thank him for calling attention to the typographical errors.

With reference to Mr. Hanson's letter, also in the March number—the deflection formula is a rational one, but unfortunately I had to make the same assumptions in its derivation that have been made in the derivation of the standard formulas for reinforced concrete. The formula that has been developed gives the correct value for the deflection of a reinforced concrete beam only when the value used for steel stress is the actual stress developed in the steel.

The true stress in the steel cannot be computed by the formula $f_s = \frac{M}{A_s jd}$, for this gives, for the accepted design stresses, a theoretical value for f_s that is from 80 to 100 per cent larger than its actual value as determined by strain measurements. The actual value of f_s is given by the quantity $\frac{KM}{A_s jd}$, when K ranges from 0.5 to 0.75. The errors involved are clearly indicated in the accompanying diagrams, Figs. 1 and 2. The effect of repeated applications of load is to increase the value of K in proportion as the tensile forces in the concrete are reduced by the cracking of the concrete on the tension side of the beam.

It is agreed, as Mr. Stone states in the March issue, that in general the published methods for the proportioning and spacing of stirrups are too cumbersome for practical use, and this is the primary reason why I presented in some detail a direct and simplified spacing method—one that can be used without approximations or interpolations. It is true that the material is not all new, but it is improper to state that the tables and other material given in *Concrete and Reinforced Concrete* by Taylor and Thompson, and in the *Handbook of Reinforced Concrete Building Construction*, are similar to the one given in my article. The table in Taylor and Thompson's book assumes that one-third of the shear is carried by the concrete and two-thirds by the stirrups, an assumption that has been discarded in modern specifications. The method given in the *Handbook of Reinforced Concrete Building Design* is a graphical solution but lacks the directness and simplicity desired for a practical method.

I do not know of any extensive series of tests which would tend to support the sweeping statement made by Mr. Stone that tests have demonstrated the ineffectiveness of vertical stirrups; the fact is that vertical stirrups are effective as web reinforcement.

DONALD M. BURMISTER, Assoc. M. Am. Soc. C.E.
Instructor in Civil Engineering
Columbia University

New York, N.Y.
May 26, 1933

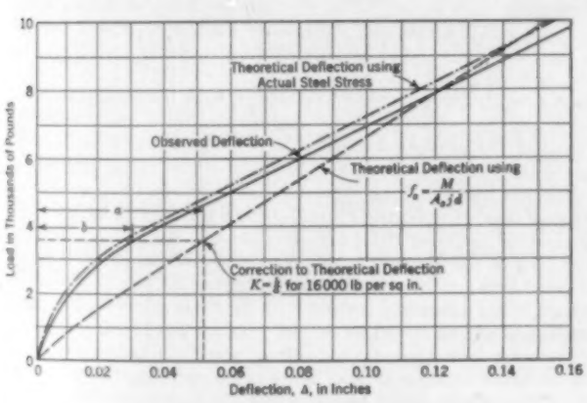

Theoretical Deflection using Actual Steel Stress
Observed Deflection
Theoretical Deflection using $f_s = \frac{M}{A_s jd}$
Correction to Theoretical Deflection $K = \frac{b}{a}$ for 16000 lb per sq in.
Load in Thousands of Pounds
Deflection, Δ, in Inches

FIG. 1. THEORETICAL AND OBSERVED DEFLECTIONS FOR CONCRETE BEAMS

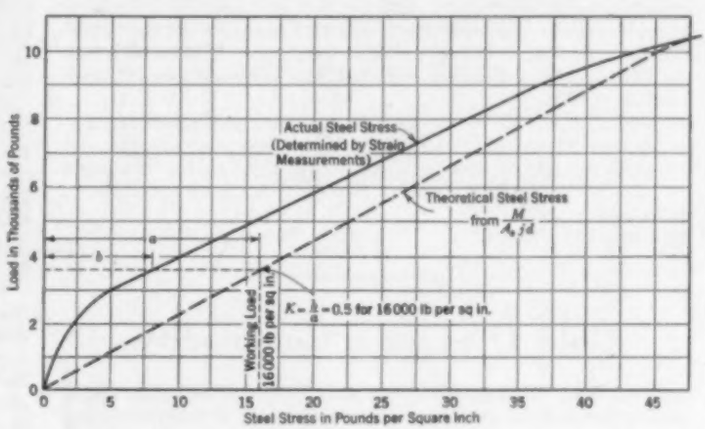

Actual Steel Stress (Determined by Strain Measurements)
Theoretical Steel Stress from $\frac{M}{A_s jd}$
Working Load 16000 lb per sq in.
$K = \frac{b}{a} = 0.5$ for 16000 lb per sq in.
Load in Thousands of Pounds
Steel Stress in Pounds per Square Inch

FIG. 2. THEORETICAL AND ACTUAL STEEL STRESSES

prototype, the speed ratio $\frac{10}{\sqrt{n}}$

model.

Defining a Navigable Waterway

DEAR SIR: The article by General Pillsbury, in the March issue, on "What Is a Navigable Waterway?" is timely. He immediately answers his own question by stating that it is ". . . a waterway that can be usefully navigated." Finally he comes to the conclusion that, ". . . the navigability of a waterway is inherently the existence of a public right to use it for trade and transportation."

I do not follow General Pillsbury to this conclusion. The correct legal definition of a navigable waterway is that of the U.S. Supreme Court in "The Daniel Ball" v. United States, 10 Wallace 557:

"Those rivers must be regarded as public navigable rivers in law, which are navigable in fact. And they are navigable in fact when they are used, or susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. And they constitute navigable waters of the United States within the meaning of the acts of Congress, in contradistinction from navigable waters of the states, when they form in their ordinary condition by themselves, or by uniting with other waters, a continued highway over which commerce is, or may be, carried on with other states or foreign countries in the customary modes in which commerce is conducted by water."

This case came up in Michigan, once a part of the Northwest Territory, to which the ordinance of 1787 applies. General Pillsbury refers to this case; he further correctly states that ". . . the mere sporadic and occasional use of a stream for the flotation of logs or poles, or even by steamboats at high water, does not make it navigable." His summary does not conform to law or to fact. Navigability is a question of fact. A stream either is, or is not, navigable. If it is navigable, the public right to use it in trade and commerce exists. If it is not navigable, the public has no such right.

There are other erroneous concepts concerning the commercial use of inland waters that are sufficiently widespread to justify comment. I shall mention certain assumptions concerning the relative rights of water- and land-borne commerce that are commonly made. Some of these are as follows: (1) that if any part of the stream is navigable, then the whole length is navigable; (2) that although the stream is not ordinarily navigable, it may at some future time be so improved as to permit commercial navigation; (3) that, at points of intersection, the public demands freer and quicker movement of water-borne commerce than of that carried on land; (4) that land transportation is subservient to water-borne commerce at points of intersection and must bear the cost of delays caused by cross currents of traffic, regardless of the relative importance of land and water commerce; and (5) that antagonistic owners of water fronts can effect solution of disputes as to relative rights and titles at a hearing before the district engineer in charge, although the district engineer is not endowed with authority to act as a court in equity.

J. E. WILLOUGHBY, M. Am. Soc. C.E.
Chief Engineer, Atlantic Coast Line Railroad Company

Wilmington, N.C.
May 27, 1933

Gold Used as a Commodity

DEAR SIR: Mr. Kent's paper on "International Relations," in the March issue, is a very able analysis of circumstances that have led to the present depression, and no one can deny that conditions in Europe would have been better in every way if the unemployed could have been occupied in useful production instead of being supported in idleness. But does he not overlook one of the most important factors in the situation which, until remedied, makes any progress so difficult as to be almost impossible? Undoubtedly it is the severe fall in prices that has mainly contributed to the present situation; but this seems largely due to the attempt to pay international debts in gold instead of in goods and services, that is, to use gold as a commodity instead of as currency.

If the creditor countries are not prepared to receive payment for debts owed them in goods or services, how can these debts be paid without causing a fall in prices? It seems to me that unless a country can organize itself so as to be independent of, and separate from, all other countries, no currency system can escape this dilemma, and an unstable world currency system is one of the main causes, if not the foundation cause, of all our troubles.

Moreover, part of this problem is apparently the difficulty of making payments by means of productive goods for debts due to supplying destructive goods, or not supplying goods at all. I feel that it is all much more complicated than Mr. Kent suggests.

J. V. NIMMO, M. Am. Soc. C.E.

Polmont, Scotland
May 14, 1933

Concrete or Steel?

TO THE EDITOR: The article by Mr. Vogel, in the March 1933 issue, is praiseworthy for its descriptions of conditions that impose large expenditures on the railroads for grade separations. The photographs presented are also very interesting as illustrating some of the meritorious types of separations recently built by the Lackawanna Railroad.

This article stresses the economic aspects of such construction and draws certain conclusions from the examples cited purporting to "indicate the considerable savings by the use of reinforced concrete . . . ." These conclusions are too broad, since they are based on dissimilar structures and may therefore be misleading. The article gives the cost of a double-track, steel, through-plate girder bridge of single span, 93½ ft long, supported on two abutments and having a shallow floor due to underclearance conditions. This cost is compared with a four-track concrete bridge 116 ft 1½ in. long, composed of four short deck spans, supported on three lines of columns and two abutments. Obviously a comparison of costs for two such radically different structures does not prove the economy of concrete over steel. The difference in cost only reaffirms the economic advantage of short spans over a long one, and of deck construction over shallow-floor through construction.

A comparison might be made between the 93½-ft single-span bridge described at Kearny and a multiple-span bridge of the same length, with intermediate supports. The lengths of the spans might then be assumed to be 19 ft 9 in., 27 ft, 27 ft, and 19 ft 9 in. The two center spans would correspond approximately to a roadway width of 50 ft, separated into two lanes by the center supports. An efficient and economical design for such a structure might call for the use of Carnegie beams placed in a longitudinal direction and supported on steel cross girders and column bents at mid-roadway and curbs. The use of five lines of beams under each track would admit of a reasonably shallow floor, and the ballast, ties, and rails might be carried on a concrete slab placed on top of, or built about, the beams.

Such a design for a double-track bridge, with E-65 loading, would require less than 180,000 lb of simple structural steel, about 31 per cent of the amount stated to have been actually used in the single-span bridge at Kearny. Because of the simplicity of the construction and the great speed possible in erection, it may be estimated that the structural steel for such a four-span bridge could be placed for less than $9,000, as compared to the $29,260.89 given as the cost of the steelwork for the single-span bridge at Kearny.

If considerations of economy alone determine the choice of the material, it is reasonably certain that for short-span work such as described, steel beams will be chosen. Apart from local conditions, considerations of economy as well as speed in construction are likely to favor structural steel alone or in combination with concrete. This conclusion is borne out by the rather general practice of other railroads for short-span work and by the recent practice of the various state highway departments for spans up to about 70 ft long.

While in other respects applauding the merit of Mr. Vogel's paper, I take exception to the conclusions or inferences presuming to demonstrate the economic superiority of reinforced concrete over structural steelwork, and contend that each problem should be carefully analyzed before determining the relative advantages of concrete, steel, or a combination of both.

S. J. OTT, M. Am. Soc. C.E.

Rutherford, N.J.
May 28, 1933

Special Assessment Securities and Municipal Improvements

SIR: The papers on assessable municipal improvements in your March and April issues prompt further comment. Special assessment may be defined as a form of taxation in which a local improvement is financed by means of a tax against the property benefited. In theory at least, the district may consist of all the real property within the municipality, so long as the benefits are variable. This theory has led to some strange decisions. Thus in Illinois it has been declared that a sewage disposal plant may be built under the Special Assessment Act but an elevated water tank may not. Obviously, topography was not considered in either case, though it would have a decided bearing.

An important phase of the special problem not fully presented in these papers is the effect of excessive and inequitable assessments on the marketability of the bonds which in most states are relied upon to finance such improvements. When the bubble bursts and the bonds are not paid, the entire financial structure of a community may be greatly injured and a large body of normally prudent investors may be ruined. Since in many cases there is no limit to the number or amount of the special assessments except the "benefit" to be derived (in the future), property in an undeveloped district may have levied against it many assessments aggregating several times even an optimistic estimate of its worth.

Thus, in Illinois, assessments for condemnation awards, water and sewerage facilities, sewage disposal plants, sewage pumping stations, services, sidewalks, electric lights, paving, and even a park, may be levied at one time, and the unfortunate lot may have a burden of $25 or more per front foot saddled on it in addition to its general taxes. If, as often happens, its intrinsic value before the improvements were put in was not over $5 a foot, the effect on the value of the bonds can be easily visualized. In Cook County, Illinois, it has been estimated that there are $300,000,000 of outstanding special assessment obligations, of which nearly 50 per cent are in default. Under the Illinois statute, the assessment is levied in advance and the property holder is given his day in court to object if he believes that his benefit is not equal to his assessment. The opportunity is valuable, but not entirely practicable, since he must be supported by lawyers, realty experts, and engineers to prove his point against the prima facie case of the municipality, and such procedure is very expensive. The jury usually becomes utterly bewildered and the result is frequently indecisive.

What can be done to improve the deplorable situation of the special assessment security market? The answer, it seems, is plain. First, the amount of special assessments that may be levied against property must be limited, and the limit must not be confined to a single levy, but should take into consideration all unpaid prior levies. Second, the municipality must assume more responsibility for an assessment that is in or may become in default, so that it will not blithely go ahead authorizing special assessments just because the optimistic property owners want it. Third, some central agency, such as the state, or possibly an estimating and planning board, should pass on the territory or district as a whole before the "boom" is permitted to start. Fourth, one part of the act governing assessments should consider the problem of defaults and provide for refunding and re-assessment operations if the assessment fails of collection. Fifth, in case of default, a merchantable title must be secured in a reasonable time, and at small expense, thus discouraging the default.

PAUL E. GREEN, M. Am. Soc. C.E.
President, Marr, Green and Opper

Chicago, Ill.
May 12, 1933

Minimizing Form Work by Curving Multiple-Arch Dams

TO THE EDITOR: The article by the late Fred A. Noetzli entitled "Economy in Form Work for Multiple-Arch Dams," in the June issue, presents one solution of the problem of developing a design that will permit the economical use of a movable form for supporting the barrel of an inclined reinforced concrete arch.

It is difficult to design such a movable form unless the intrados has a constant radius and parallel spring lines. If the piers of a multiple-arch dam are of uniform thickness and are parallel, these arch conditions exist. In the case of a high dam, however, it is probable that economy will require the use of piers with battered sides, in which case the problem of obtaining parallel spring lines calls for special treatment. Mr. Noetzli's plan of building short parts of the arch barrels integrally with the piers may be used. Another very satisfactory method was developed in the construction of the Victoria Dam on the Ontonagon River in Upper Michigan.

The Victoria Dam includes a multiple-arch section composed of four arches inclined at approximately 45 deg, each with a radius of 34 ft 9 in. and a span of 68 ft 5¼ in. between spring lines. The highest arch measures 114 ft vertically from pier footing to pond elevation. The largest pier is 138 ft 11 in. long at its footing. The piers for the maximum arch vary in thickness from 9 ft at the footing to 5 ft at the top. Therefore, if the axes of the piers were parallel, the spring lines of the arch intrados would diverge 4 ft in progressing from bottom to top.

A scheme somewhat similar to that described by Mr. Noetzli was considered, as was also the expedient of building the piers with corbels at the spring lines, the corbels to increase in size as the pier thickness diminished, thus keeping the arch span uniform. Either of these plans appeared to give rise to undue complications in the forms, and the following adaptation of design was evolved as the result of consultation between the designing engineers and the contractors.

It was determined that there were no features of the design that made it essential that the piers be maintained parallel. Therefore, the structure was designed as a multiple-arch dam slightly curved in plan. The axes of the piers were made to converge downstream sufficiently to compensate for the batter of their sides, the result being that the spring lines of each arch became parallel, although the spring lines of any given arch were not parallel to those of any other one.

The result was a very considerable convenience and economy in construction without any sacrifice of stability or economy of design.

E. L. CHANDLER, M. Am. Soc. C.E.
Engineer, Price Brothers Company, Dayton, Ohio

New London, Conn.
June 1, 1933

A Practical Formula for River Discharge

DEAR SIR: I beg to call your attention to the fact that the following formula for river discharge is applicable to most of the results of actual observation and conforms to the requirements of the Reynolds-Rayleigh law of dynamic similarity:

$$V = C\sqrt{RS} \quad \text{(de Chezy)}$$

$$C = \frac{23 + \frac{1}{n}}{1 + \frac{26}{\sqrt[3]{N}}} \quad \text{(metric units)}$$

where N is the Reynolds number, VR/η, in which η is the kinematic viscosity. $N = 4{,}000{,}000\ VR$ for metric units at a temperature of 20 C.

It will be noticed that this formula is based on Kutter's but omits the very dubious slope terms. For medium-sized rivers it implies a dependence on the water temperature, but does not do so for very large rivers. With a value for $n = 1/81$, it fits smooth pipe results quite well.

HERBERT CHATLEY
Engineer-in-Chief, Whangpoo Conservancy Board

Shanghai, China
May 16, 1933

Analyzing Portal Effect on Top Chords

TO THE EDITOR: Referring to the article entitled "Portal Effect on Top-Chord Stresses," which appeared in the June issue of CIVIL ENGINEERING, for the old-type bridge with hung floors and light sway bracing, Professor Lambert is correct in his statement that no stress exists in the upper chord due to overturning effect of wind on the upper chord. In analyzing this problem some of the older textbook writers were in error because of their failure to include all the forces involved.

Taking the entire bridge as a free body, the upward reactions of the leeward truss are each $\frac{Ph}{k}$, where P is one-half the total horizontal wind load, h the depth of the truss, and k the distance between trusses. To balance these reactions somewhere on the truss there must be equal downward forces. These downward forces come from stresses in the diagonal members of the portal bracing, they being external forces when the truss is taken as a free body. These stresses may be resolved into two components in the plane of the portal frame, one along the end post and one along the upper chord of the portal bracing. The latter is balanced by the stress in this portal upper chord.

The component along the end post may be divided into two components in the plane of the main truss, one acting vertically and the other horizontally. The vertical component equals $\frac{Ph}{k}$, to balance the previously mentioned reactions, while the horizontal component equals $\frac{Ph \tan \alpha}{k}$, where α is the angle which the end post makes with the vertical. Since $\tan \alpha$ equals $\frac{p}{h}$, where p is the panel length, the horizontal component becomes $\frac{Pp}{k}$. The loads and the resulting stresses are shown in Fig. 1.

In the case of bridges built within the last twenty years, where the floor beams are riveted into the trusses and where heavy

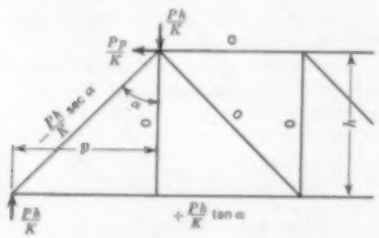


FIG. 1. LOADS AND RESULTING STRESSES DUE TO WIND ON UPPER CHORD OF BRIDGE TRUSS

sway members are used, the stress will be quite different, particularly if there is a concrete floor. A part of the wind load will travel through the sway system down to the lower chord and thence out through the lower lateral system and the concrete deck. In this case there will be vertical loads at all upper and lower panel points, the former representing the effect of the sway diagonals and the latter the effect of the floor beams acting on the truss.

Just what percentage of the load goes this way and what percentage goes through the upper lateral system and down through the portal is not easy to determine. Even if all went through the portal system, if the end floor beam fixes the lower ends of the end posts, the stresses would be different from those given in Fig. 1. These observations indicate that the errors in some of the older texts have not resulted in over-sized top chords.

R. P. DAVIS, M. Am. Soc. C.E.
Dean of the College of Engineering
West Virginia University

Morgantown, W.Va.
June 8, 1933

Crane-Support Stresses Calculated by Method of Least Work

TO THE EDITOR: The structure referred to in the article by Mr. Jacob, "Torsional Stresses in a Crane Support," in the May issue, is a statically indeterminate space framework and can be solved by the methods given in a number of standard texts on the theory of structures. It is stated in this article that the structure is a steel tower bearing a locomotive crane and I assume, therefore, it must be so supported that each of the four lower corners could have a vertical reaction. Mr. Jacob assumes that these vertical reactions are zero. If this assumption is made, the bar stresses can be found by statics—analytically as well as graphically—but the results must be recognized as being merely approximate. In this structure only the horizontal reactions B and the stresses in bars q and s can be determined by statics. The vertical reactions and the stresses in all bars, except q and s, are functions of the elastic properties of the bars and not alone of the geometry of the structure.

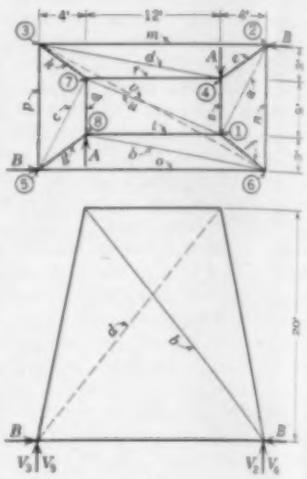


FIG. 1. DIMENSIONED CRANE STRUCTURE SOLVED BY METHOD OF LEAST WORK

To be specific I assigned dimensions to the structure, as shown in the accompanying Fig. 1, and took each of the two loads A as unity. Selecting bar u as the redundant bar, I assigned areas to the members (at random, but always preserving the symmetry of the structure) and made a solution by the method of least work. This is designated as Solution I. Then the areas of certain bars were changed and a second solution made, which is called Solution II. The adopted areas and the resulting stresses are given in Table I.

TABLE I. AREAS OF MEMBERS AND STRESSES

Areas in Square Inches, and Stresses in Same Units as A

$A = 1$		Solution I		Solution II	
		Area	Stress	Area	Stress
Reactions	B	..	+1.090	..	+1.090
	V_3, V_4	..	−0.200	..	−0.736
	V_5, V_6	..	+0.200	..	+0.736
Bar Stresses	s, q	..	−1.000	..	−1.000
	u	20	+1.000	10	+0.669
	v	10	+0.700	10	+1.153
	t, r	20	−0.923	10	−0.617
	a, c	20	+1.224	20	+1.477
	b, d	20	+1.190	10	+0.796
	e, g	20	−0.951	10	−0.637
	f, h	20	−1.150	20	−1.388
	m, o	15	−1.125	15	−1.232
	n, p	10	−0.300	10	−0.447

Note that the bar stresses differ widely in the two solutions and that the vertical reactions, instead of being zero, are 0.2 of the load A for one solution and 0.74 of the load for the other. Only in a special case would the vertical reactions be zero. Accordingly, Mr. Jacob's solution appears to be an approximate graphical solution of a problem that can be solved accurately—and about as easily—by the standard analytical methods.

ALFRED T. WAIDELICH, Jun. Am. Soc. C.E.
Assistant Instructor in Civil Engineering
Massachusetts Institute of Technology

Cambridge, Mass.
June 3, 1933

SOCIETY AFFAIRS

Official and Semi-Official

National Industrial Recovery Act Becomes Law

Way Cleared for Revival of Employment by a Normal Program of Public Works Construction

ON MAY 9, 1932, the Executive Committee of the Society adopted a formal resolution approving in principle a normal program of public works construction as the most effective immediate means of increasing purchasing power, stimulating trade recovery, and reviving employment, and urged Congress to extend Federal credit facilities to solvent states, counties, and municipalities to enable them to carry out their normal programs of necessary and productive public works. A Society Committee on Public Works, with John P. Hogan, M. Am. Soc. C.E., as chairman, was appointed to use its best efforts to make the principles expressed in this resolution operative in fact.

On July 21 President Hoover signed the Emergency Relief and Construction Act of 1932. Among its provisions Title II provided for loans through the Reconstruction Finance Corporation to states, municipalities, and private corporations under certain conditions, for self-liquidating construction projects, which would be found to have that character without the aid of taxation. The sum of $1,500,000,000 was made available. Up to June 1, 1933, the sum of $201,291,000 had been approved as subject to loan in 35 states and territories. A small percentage only, however, had actually been loaned and made effective on new construction.

At its meeting on January 16, 1933, the Board of Direction adopted another resolution urging that certain liberalizations be made in the act of 1932: removal of the self-liquidating stipulation; limitation of projects to those which are needful and economically sound; inclusion of the provision that municipalities may set up such agency as may be satisfactory to the Reconstruction Finance Corporation, to regulate rents, etc., in housing projects; increasing the kinds of work devoted to public use which are eligible for loans; removal of the restriction relative to taxation; and reduction of interest rates on loans to the lowest point consistent with the condition that the Government be fully reimbursed for its loan. The Society's Committee on Public Works continued its efforts to obtain the liberalization of the act in accordance with the Board's resolution.

On June 13, 1933, the National Industrial Recovery Act was passed by Congress. On June 16 it was signed by President Roosevelt and became law. Among its features Title II provides for a public works program amounting to $3,300,000,000 to be carried forward by Federal, state, county, municipal, and other political subdivision agencies, including also public-benefiting private projects. Grants are to be made through an Administrator of Public Works for construction and improvement projects up to 30 per cent of the cost of labor and materials. The act is printed here in its entirety.

AN ACT To encourage national industrial recovery, to foster fair competition, and to provide for the construction of certain useful public works, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

TITLE I—INDUSTRIAL RECOVERY

Declaration of Policy

SECTION 1. A national emergency productive of widespread unemployment and disorganization of industry, which burdens interstate and foreign commerce, affects the public welfare, and undermines the standards of living of the American people, is hereby declared to exist. It is hereby declared to be the policy of Congress to remove obstructions to the free flow of interstate and foreign commerce which tend to diminish the amount thereof; and to provide for the general welfare by promoting the organization of industry for the purpose of cooperative action among trade groups, to induce and maintain united action of labor and management under adequate governmental sanctions and supervision, to eliminate unfair competitive practices, to promote the fullest possible utilization of the present productive capacity of industries, to avoid undue restriction of production (except as may be temporarily required), to increase the consumption of industrial and agricultural products by increasing purchasing power, to reduce and relieve unemployment, to improve standards of labor, and otherwise to rehabilitate industry and to conserve natural resources.

Administrative Agencies

SEC. 2. (a) To effectuate the policy of this title, the President is hereby authorized to establish such agencies, to accept and utilize such voluntary and uncompensated services, to appoint, without regard to the provisions of the civil service laws, such officers and employees, and to utilize such Federal officers and employees, and, with the consent of the State, such State and local officers and employees, as he may find necessary, to prescribe their authorities, duties, responsibilities, and tenure, and, without regard to the Classification Act of 1923, as amended, to fix the compensation of any officers and employees so appointed.

(b) The President may delegate any of his functions and powers under this title to such officers, agents, and employees as he may designate or appoint, and may establish an industrial planning and research agency to aid in carrying out his functions under this title.

(c) This title shall cease to be in effect and any agencies established hereunder shall cease to exist at the expiration of two years after the date of enactment of this Act, or sooner if the President shall by proclamation or the Congress shall by joint resolution declare that the emergency recognized by section 1 has ended.

Codes of Fair Competition

SEC. 3. (a) Upon the application to the President by one or more trade or industrial associations or groups, the President may approve a code or codes of fair competition for the trade or industry or subdivision thereof, represented by the applicant or applicants, if the President finds (1) that such associations or groups impose no inequitable restrictions on admission to membership therein and are truly representative of such trades or industries or subdivisions thereof, and (2) that such code or codes are not designed to promote monopolies or to eliminate or oppress small enterprises and will not operate to discriminate against them, and will tend to effectuate the policy of this title: *Provided*, That such code or codes shall not permit monopolies or monopolistic practices: *Provided further*, That where such code or codes affect the services and welfare of persons engaged in other steps of the economic process, nothing in this section shall deprive such persons of the right to be heard prior to approval by the President of such code or codes. The President may, as a condition of his approval of any such code, impose such conditions (including requirements for the making of reports and the keeping of accounts) for the protection of consumers, competitors, employees, and others, and in furtherance of the public interest, and may provide such exceptions to and exemptions from the provisions of such code, as the President in his discretion deems necessary to effectuate the policy herein declared.

(b) After the President shall have approved any such code, the provisions of such code shall be the standards of fair competition for such trade or industry or subdivision thereof. Any violation of such standards in any transaction in or affecting interstate or foreign commerce shall be deemed an unfair method of competition in commerce within the meaning of the Federal Trade Commission Act, as amended; but nothing in this title shall be construed to

impair the powers of the Federal Trade Commission under such Act, as amended.

(c) The several district courts of the United States are hereby invested with jurisdiction to prevent and restrain violations of any code of fair competition approved under this title; and it shall be the duty of the several district attorneys of the United States, in their respective districts, under the direction of the Attorney General, to institute proceedings in equity to prevent and restrain such violations.

(d) Upon his own motion, or if complaint is made to the President that abuses inimical to the public interest and contrary to the policy herein declared are prevalent in any trade or industry or subdivision thereof, and if no code of fair competition therefor has theretofore been approved by the President, the President, after such public notice and hearing as he shall specify, may prescribe and approve a code of fair competition for such trade or industry or subdivision thereof, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of this section.

(e) On his own motion, or if any labor organization, or any trade or industrial organization, association, or group, which has complied with the provisions of this title, shall make complaint to the President that any article or articles are being imported into the United States in substantial quantities or increasing ratio to domestic production of any competitive article or articles and on such terms or under such conditions as to render ineffective or seriously to endanger the maintenance of any code or agreement under this title, the President may cause an immediate investigation to be made by the United States Tariff Commission, which shall give precedence to investigations under this subsection, and if, after such investigation and such public notice and hearing as he shall specify, the President shall find the existence of such facts, he shall, in order to effectuate the policy of this title, direct that the article or articles concerned shall be permitted entry into the United States only upon such terms and conditions and subject to the payment of such fees and to such limitations in the total quantity which may be imported (in the course of any specified period or periods) as he shall find it necessary to prescribe in order that the entry thereof shall not render or tend to render ineffective any code or agreement made under this title. In order to enforce any limitations imposed on the total quantity of imports, in any specified period or periods, of any article or articles under this subsection, the President may forbid the importation of such article or articles unless the importer shall have first obtained from the Secretary of the Treasury a license pursuant to such regulations as the President may prescribe. Upon information of any action by the President under this subsection the Secretary of the Treasury shall, through the proper officers, permit entry of the article or articles specified only upon such terms and conditions and subject to such fees, to such limitations in the quantity which may be imported, and to such requirements of license, as the President shall have directed. The decision of the President as to facts shall be conclusive. Any condition or limitation of entry under this subsection shall continue in effect until the President shall find and inform the Secretary of the Treasury that the conditions which led to the imposition of such condition or limitation upon entry no longer exists.

(f) When a code of fair competition has been approved or prescribed by the President under this title, any violation of any provision thereof in any transaction in or affecting interstate or foreign commerce shall be a misdemeanor and upon conviction thereof an offender shall be fined not more than $500 for each offense, and each day such violation continues shall be deemed a separate offense.

AGREEMENTS AND LICENSES

SEC. 4. (a) The President is authorized to enter into agreements with, and to approve voluntary agreements between and among, persons engaged in a trade or industry, labor organizations, and trade or industrial organizations, associations, or groups, relating to any trade or industry, if in his judgment such agreements will aid in effectuating the policy of this title with respect to transactions in or affecting interstate or foreign commerce, and will be consistent with the requirements of clause (2) of subsection (a) of section 3 for a code of fair competition.

(b) Whenever the President shall find that destructive wage or price cutting or other activities contrary to the policy of this title are being practiced in any trade or industry or any subdivision thereof, and, after such public notice and hearing as he shall specify, shall find it essential to license business enterprises in order to make effective a code of fair competition or an agreement under this title or otherwise to effectuate the policy of this title, and shall publicly so announce, no person shall, after a date fixed in such announcement, engage in or carry on any business, in or affecting interstate or foreign commerce, specified in such announcement, unless he shall have first obtained a license issued pursuant to such regulations as the President shall prescribe. The President may suspend or revoke any such license, after due notice and opportunity for hearing, for violations of the terms or conditions thereof. Any order of the President suspending or revoking any such license shall be final if in accordance with law. Any person who, without such a license or in violation of any condition thereof, carries on any such business for which a license is so required, shall, upon conviction thereof, be fined not more than $500, or imprisoned not more than six months, or both, and each day such violation continues shall be deemed a separate offense. Notwithstanding the provisions of section 2 (c), this subsection shall cease to be in effect at the expiration of one year after the date of enactment of this Act or sooner if the President shall by proclamation or the Congress shall by joint resolution declare that the emergency recognized by section 1 has ended.

SEC. 5. While this title is in effect (or in the case of a license, while section 4(a) is in effect) and for sixty days thereafter, any code, agreement, or license approved, prescribed, or issued and in effect under this title, and any action complying with the provisions thereof taken during such period, shall be exempt from the provisions of the antitrust laws of the United States.

Nothing in this Act, and no regulation thereunder, shall prevent an individual from pursuing the vocation of manual labor and selling or trading the products thereof; nor shall anything in this Act, or regulation thereunder, prevent anyone from marketing or trading the produce of his farm.

LIMITATIONS UPON APPLICATION OF TITLE

SEC. 6. (a) No trade or industrial association or group shall be eligible to receive the benefit of the provisions of this title until it files with the President a statement containing such information relating to the activities of the association or group as the President shall by regulation prescribe.

(b) The President is authorized to prescribe rules and regulations designed to insure that any organization availing itself of the benefits of this title shall be truly representative of the trade or industry or subdivision thereof represented by such organization. Any organization violating any such rule or regulation shall cease to be entitled to the benefits of this title.

(c) Upon the request of the President, the Federal Trade Commission shall make such investigations as may be necessary to enable the President to carry out the provisions of this title, and for such purposes the Commission shall have all the powers vested in it with respect of investigations under the Federal Trade Commission Act, as amended.

SEC. 7. (a) Every code of fair competition, agreement, and license approved, prescribed, or issued under this title shall contain the following conditions: (1) That employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint, or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection; (2) that no employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing; and (3) that employers shall comply with the maximum hours of labor, minimum rates of pay, and other conditions of employment, approved or prescribed by the President.

(b) The President shall, so far as practicable, afford every opportunity to employers and employees in any trade or industry or subdivision thereof with respect to which the conditions referred to in clauses (1) and (2) of subsection (a) prevail, to establish by mutual agreement, the standards as to the maximum hours of labor, minimum rates of pay, and such other conditions of employment as may be necessary in such trade or industry or subdivision thereof to effectuate the policy of this title; and the standards

established in such agreements, when approved by the President, shall have the same effect as a code of fair competition, approved by the President under subsection (a) of section 3.

(c) Where no such mutual agreement has been approved by the President he may investigate the labor practices, policies, wages, hours of labor, and conditions of employment in such trade or industry or subdivision thereof; and upon the basis of such investigations, and after such hearings as the President finds advisable, he is authorized to prescribe a limited code of fair competition fixing such maximum hours of labor, minimum rates of pay, and other conditions of employment in the trade or industry or subdivision thereof investigated as he finds to be necessary to effectuate the policy of this title, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of section 3. The President may differentiate according to experience and skill of the employees affected and according to the locality of employment; but no attempt shall be made to introduce any classification according to the nature of the work involved which might tend to set a maximum as well as a minimum wage.

(d) As used in this title, the term "person" includes any individual, partnership, association, trust, or corporation; and the terms "interstate and foreign commerce" and "interstate or foreign commerce" include, except where otherwise indicated, trade or commerce among the several States and with foreign nations, or between the District of Columbia or any Territory of the United States and any State, Territory, or foreign nation, or between any insular possessions or other places under the jurisdiction of the United States, or between any such possession or place and any State or Territory of the United States or the District of Columbia or any foreign nation, or within the District of Columbia or any Territory or any insular possession or other place under the jurisdiction of the United States.

APPLICATION OF AGRICULTURAL ADJUSTMENT ACT

SEC. 8. (a) This title shall not be construed to repeal or modify any of the provisions of title I of the Act entitled "An Act to relieve the existing national economic emergency by increasing agricultural purchasing power, to raise revenue for extraordinary expenses incurred by reason of such emergency, to provide emergency relief with respect to agricultural indebtedness, to provide for the orderly liquidation of joint-stock land banks, and for other purposes," approved May 12, 1933; and such title I of said Act approved May 12, 1933, may for all purposes be hereafter referred to as the "Agricultural Adjustment Act."

(b) The President may, in his discretion, in order to avoid conflicts in the administration of the Agricultural Adjustment Act and this title, delegate any of his functions and powers under this title with respect to trades, industries, or subdivisions thereof which are engaged in the handling of any agricultural commodity or product thereof, or of any competing commodity or product thereof, to the Secretary of Agriculture.

OIL REGULATION

SEC. 9. (a) The President is further authorized to initiate before the Interstate Commerce Commission proceedings necessary to prescribe regulations to control the operations of oil pipe lines and to fix reasonable, compensatory rates for the transportation of petroleum and its products by pipe lines, and the Interstate Commerce Commission shall grant preference to the hearings and determination of such cases.

(b) The President is authorized to institute proceedings to divorce from any holding company any pipe-line company controlled by such holding company which pipe-line company by unfair practices or by exorbitant rates in the transportation of petroleum or its products tends to create a monopoly.

(c) The President is authorized to prohibit the transportation in interstate and foreign commerce of petroleum and the products thereof produced or withdrawn from storage in excess of the amount permitted to be produced or withdrawn from storage by any State law or valid regulation or order prescribed thereunder, by any board, commission, officer, or other duly authorized agency of a State. Any violation of any order of the President issued under the provisions of this subsection shall be punishable by fine of not to exceed $1,000, or imprisonment for not to exceed six months, or both.

RULES AND REGULATIONS

SEC. 10. (a) The President is authorized to prescribe such rules and regulations as may be necessary to carry out the purposes of this title, and fees for licenses and for filing codes of fair competition and agreements, and any violation of any such rule or regulation shall be punishable by fine of not to exceed $500, or imprisonment for not to exceed six months, or both.

(b) The President may from time to time cancel or modify any order, approval, license, rule, or regulation issued under this title; and each agreement, code of fair competition, or license approved, prescribed, or issued under this title shall contain an express provision to that effect.

TITLE II—PUBLIC WORKS AND CONSTRUCTION PROJECTS

FEDERAL EMERGENCY ADMINISTRATION OF PUBLIC WORKS

SECTION 201. (a) To effectuate the purposes of this title, the President is hereby authorized to create a Federal Emergency Administration of Public Works, all the powers of which shall be exercised by a Federal Emergency Administrator of Public Works (hereafter referred to as the "Administrator"), and to establish such agencies, to accept and utilize such voluntary and uncompensated services, to appoint, without regard to the civil service laws, such officers and employees, and to utilize such Federal officers and employees, and, with the consent of the State, such State and local officers and employees as he may find necessary, to prescribe their authorities, duties, responsibilities, and tenure, and, without regard to the Classification Act of 1923, as amended, to fix the compensation of any officers and employees so appointed. The President may delegate any of his functions and powers under this title to such officers, agents, and employees as he may designate or appoint.

(b) The Administrator may, without regard to the civil service laws or the Classification Act of 1923, as amended, appoint and fix the compensation of such experts and such other officers and employees as are necessary to carry out the provisions of this title; and may make such expenditures (including expenditures for personal services and rent at the seat of government and elsewhere, for law books and books of reference, and for paper, printing and binding) as are necessary to carry out the provisions of this title.

(c) All such compensation, expenses, and allowances shall be paid out of funds made available by this Act.

(d) After the expiration of two years after the date of the enactment of this Act, or sooner if the President shall by proclamation or the Congress shall by joint resolution declare that the emergency recognized by section 1 has ended, the President shall not make any further loans or grants or enter upon any new construction under this title, and any agencies established hereunder shall cease to exist and any of their remaining functions shall be transferred to such departments of the Government as the President shall designate: *Provided*, That he may issue funds to a borrower under this title prior to January 23, 1939, under the terms of any agreement, or any commitment to bid upon or purchase bonds, entered into with such borrower prior to the date of termination, under this section, of the power of the President to make loans.

SEC. 202. The Administrator, under the direction of the President, shall prepare a comprehensive program of public works, which shall include among other things the following: (a) Construction, repair, and improvement of public highways and park ways, public buildings, and any publicly owned instrumentalities and facilities; (b) conservation and development of natural resources, including control, utilization, and purification of waters, prevention of soil or coastal erosion, development of water power, transmission of electrical energy, and construction of river and harbor improvements and flood control and also the construction of any river or drainage improvement required to perform or satisfy any obligation incurred by the United States through a treaty with a foreign Government heretofore ratified and to restore or develop for the use of any State or its citizens water taken from or denied to them by performance on the part of the United States of treaty obligations heretofore assumed: *Provided*, That no river or harbor improvements shall be carried out unless they shall have heretofore or hereafter been adopted by the Congress or are recommended by the Chief of Engineers of the United States Army; (c) any projects of the character heretofore constructed or carried on either directly by public authority or with public aid to serve the

interests of the general public; (d) construction, reconstruction, alteration, or repair under public regulation or control of low-cost housing and slum-clearance projects; (e) any project (other than those included in the foregoing classes) of any character heretofore eligible for loans under subsection (a) of section 201 of the Emergency Relief and Construction Act of 1932, as amended, and paragraph (3) of such subsection (a) shall for such purposes be held to include loans for the construction or completion of hospitals the operation of which is partly financed from public funds, and of reservoirs and pumping plants and for the construction of dry docks; and if in the opinion of the President it seems desirable, the construction of naval vessels within the terms and/or limits established by the London Naval Treaty of 1930 and of aircraft required therefor and construction of heavier-than-air aircraft and technical construction for the Army Air Corps and such Army housing projects as the President may approve, and provision of original equipment for the mechanization or motorization of such Army tactical units as he may designate: *Provided, however*, That in the event of an international agreement for the further limitation of armament, to which the United States is signatory, the President is hereby authorized and empowered to suspend, in whole or in part, any such naval or military construction or mechanization and motorization of Army units: *Provided further*, That this title shall not be applicable to public works under the jurisdiction or control of the Architect of the Capitol or of any commission or committee for which such Architect is the contracting and/or executive officer.

SEC. 203. (a) With a view to increasing employment quickly (while reasonably securing any loans made by the United States) the President is authorized and empowered, through the Administrator or through such other agencies as he may designate or create, (1) to construct, finance, or aid in the construction or financing of any public-works project included in the program prepared pursuant to section 202; (2) upon such terms as the President shall prescribe, to make grants to States, municipalities, or other public bodies for the construction, repair, or improvement of any such project, but no such grant shall be in excess of 30 per centum of the cost of the labor and materials employed upon such project; (3) to acquire by purchase, or by exercise of the power of eminent domain, any real or personal property in connection with the construction of any such project, and to sell any security acquired or any property so constructed or acquired or to lease any such property with or without the privilege of purchase: *Provided*, That all moneys received from any such sale or lease or the repayment of any loan shall be used to retire obligations issued pursuant to section 209 of this Act, in addition to any other moneys required to be used for such purpose; (4) to aid in the financing of such railroad maintenance and equipment as may be approved by the Interstate Commerce Commission as desirable for the improvement of transportation facilities; and (5) to advance, upon request of the Commission having jurisdiction of the project, the unappropriated balance of the sum authorized for carrying out the provisions of the Act entitled "An Act to provide for the construction and equipment of an annex to the Library of Congress," approved June 13, 1930 (46 Stat. 583); such advance to be expended under the direction of such Commission and in accordance with such Act: *Provided*, That in deciding to extend any aid or grant hereunder to any State, county, or municipality the President may consider whether action is in process or in good faith assured therein reasonably designed to bring the ordinary current expenditures thereof within the prudently estimated revenues thereof. The provisions of this section and section 202 shall extend to public works in the several States, Hawaii, Alaska, the District of Columbia, Puerto Rico, the Canal Zone, and the Virgin Islands.

(b) All expenditures for authorized travel by officers and employees, including subsistence, required on account of any Federal public-works projects, shall be charged to the amounts allocated to such projects, notwithstanding any other provisions of law; and there is authorized to be employed such personal services in the District of Columbia and elsewhere as may be required to be engaged upon such work and to be in addition to employees otherwise provided for, the compensation of such additional personal services to be a charge against the funds made available for such construction work.

(c) In the acquisition of any land or site for the purposes of Federal public buildings and in the construction of such buildings provided for in this title, the provisions contained in sections 305 and 306 of the Emergency Relief and Construction Act of 1932, as amended, shall apply.

(d) The President, in his discretion, and under such terms as he may prescribe, may extend any of the benefits of this title to any State, county, or municipality notwithstanding any constitutional or legal restriction or limitation on the right or power of such State, county, or municipality to borrow money or incur indebtedness.

SEC. 204. (a) For the purpose of providing for emergency construction of public highways and related projects, the President is authorized to make grants to the highway departments of the several States in an amount not less than $400,000,000, to be expended by such departments in accordance with the provisions of the Federal Highway Act, approved November 9, 1921, as amended and supplemented, except as provided in this title, as follows:

(1) For expenditure in emergency construction on the Federal aid highway system and extensions thereof into and through municipalities. The amount apportioned to any State under this paragraph may be used to pay all or any part of the cost of surveys, plans, and of highway and bridge construction including the elimination of hazards to highway traffic, such as the separation of grades at crossing, the reconstruction of existing railroad grade crossing structures, the relocation of highways to eliminate railroad crossings, the widening of narrow bridges and roadways, the building of footpaths, the replacement of unsafe bridges, the construction of routes to avoid congested areas, the construction of facilities to improve accessibility and the free flow of traffic, and the cost of any other construction that will provide safer traffic facilities or definitely eliminate existing hazards to pedestrian or vehicular traffic. No funds made available by this title shall be used for the acquisition of any land, right of way, or easement in connection with any railroad grade elimination project.

(2) For expenditure in emergency construction on secondary or feeder roads to be agreed upon by the State highway departments and the Secretary of Agriculture: *Provided*, That the State or responsible political subdivision shall provide for the proper maintenance of said roads. Such grants shall be available for payment of the full cost of surveys, plans, improvement, and construction of secondary or feeder roads, on which projects shall be submitted by the State highway department and approved by the Secretary of Agriculture.

(b) Any amounts allocated by the President for grants under subsection (a) of this section shall be apportioned among the several States, seven-eighths in accordance with the provisions of section 21 of the Federal Highway Act, approved November 9, 1921, as amended and supplemented (which Act is hereby further amended for the purposes of this title to include the District of Columbia), and one-eighth in the ratio which the population of each State bears to the total population of the United States, according to the latest decennial census, and shall be available on July 1, 1933, and shall remain available until expended; but no part of the funds apportioned to any States need be matched by the State, and such funds may also be used in lieu of State funds to match unobligated balances of previous apportionments of regular Federal-aid appropriations.

(c) All contracts involving the expenditure of such grants shall contain provisions establishing minimum rates of wages, to be predetermined by the State highway department, which contractors shall pay to skilled and unskilled labor, and such minimum rates shall be stated in the invitation for bids and shall be included in proposals for bids for the work.

(d) In the expenditure of such amounts, the limitations in the Federal Highway Act, approved November 9, 1921, as amended and supplemented, upon highway construction, reconstruction, and bridges within municipalities and upon payments per mile which may be made from Federal funds, shall not apply.

(e) As used in this section the term "State" includes the Territory of Hawaii and the District of Columbia. The term "highway" as defined in the Federal Highway Act approved November 9, 1921, as amended and supplemented, for the purposes of this section, shall be deemed to include such main parkways as may be designated by the State and approved by the Secretary of Agriculture as part of the Federal-aid highway system.

(f) Whenever, in connection with the construction of any highway project under this section or section 202 of this Act, it is necessary to acquire rights of way over or through any property or tracts of land owned and controlled by the Government of the

United States, it shall be the duty of the proper official of the Government of the United States having control of such property or tracts of land with the approval of the President and the Attorney General of the United States, and without any expense whatsoever to the United States, to perform any acts and to execute any agreements necessary to grant the rights of way so required, but if at any time the land or the property the subject of the agreement shall cease to be used for the purposes of the highway, the title in and the jurisdiction over the land or property shall automatically revert to the Government of the United States and the agreement shall so provide.

(g) Hereafter in the administration of the Federal Highway Act, and Acts amendatory thereof or supplementary thereto, the first paragraph of section 9 of said Act shall not apply to publicly owned toll bridges or approaches thereto, operated by the highway department of any State, subject, however, to the condition that all tolls received from the operation of any such bridge, less the actual cost of operation and maintenance, shall be applied to the repayment of the cost of its construction or acquisition, and when the cost of its construction or acquisition shall have been repaid in full, such bridge thereafter shall be maintained and operated as a free bridge.

SEC. 205. (a) Not less than $50,000,000 of the amount made available by this Act shall be allotted for (A) national forest highways, (B) national forest roads, trails, bridges, and related projects, (C) national park roads and trails in national parks owned or authorized, (D) roads on Indian reservations, and (E) roads through public lands, to be expended in the same manner as provided in paragraph (2) of section 301 of the Emergency Relief and Construction Act of 1932, in the case of appropriations allocated for such purposes, respectively, in such section 301, to remain available until expended.

(b) The President may also allot funds made available by this Act for the construction, repair, and improvement of public highways in Alaska, the Canal Zone, Puerto Rico, and the Virgin Islands.

SEC. 206. All contracts let for construction projects and all loans and grants pursuant to this title shall contain such provisions as are necessary to insure (1) that no convict labor shall be employed on any such project; (2) that (except in executive, administrative, and supervisory positions), so far as practicable and feasible, no individual directly employed on any such project shall be permitted to work more than thirty hours in any one week; (3) that all employees shall be paid just and reasonable wages which shall be compensation sufficient to provide, for the hours of labor as limited, a standard of living in decency and comfort; (4) that in the employment of labor in connection with any such project, preference shall be given, where they are qualified, to ex-service men with dependents, and then in the following order: (A) To citizens of the United States and aliens who have declared their intention of becoming citizens, who are bona fide residents of the political subdivision and/or county in which the work is to be performed, and (B) to citizens of the United States and aliens who have declared their intention of becoming citizens, who are bona fide residents of the State, Territory, or district in which the work is to be performed: *Provided*, That these preferences shall apply only where such labor is available and qualified to perform the work to which the employment relates; and (5) that the maximum of human labor shall be used in lieu of machinery wherever practicable and consistent with sound economy and public advantage.

SEC. 207. (a) For the purpose of expediting the actual construction of public works contemplated by this title and to provide a means of financial assistance to persons under contract with the United States to perform such construction, the President is authorized and empowered, through the Administrator or through such other agencies as he may designate or create, to approve any assignment executed by any such contractor, with the written consent of the surety or sureties upon the penal bond executed in connection with his contract, to any national or State bank, or his claim against the United States, or any part of such claim, under such contract; and any assignment so approved shall be valid for all purposes, notwithstanding the provisions of sections 3737 and 3477 of the Revised Statutes, as amended.

(b) The funds received by a contractor under any advances made in consideration of any such assignment are hereby declared to be trust funds in the hands of such contractor to be first applied to the payment of claims of subcontractors, architects, engineers, surveyors, laborers, and material men in connection with the project, to the payment of premiums on the penal bond or bonds, and premiums accruing during the construction of such project on insurance policies taken in connection therewith. Any contractor and any officer, director, or agent of any such contractor, who applies, or consents to the application of, such funds for any other purpose and fails to pay any claim or premium hereinbefore mentioned, shall be deemed guilty of a misdemeanor and shall be punished by a fine of not more than $1,000 or by imprisonment for not more than one year, or by both such fine and imprisonment.

(c) Nothing in this section shall be considered as imposing upon the assignee any obligation to see to the proper application of the funds advanced by the assignee in consideration of such assignment.

SUBSISTENCE HOMESTEADS

SEC. 208. To provide for aiding the redistribution of the overbalance of population in industrial centers $25,000,000 is hereby made available to the President, to be used by him through such agencies as he may establish and under such regulations as he may make, for making loans for and otherwise aiding in the purchase of subsistence homesteads. The moneys collected as repayment of said loans shall constitute a revolving fund to be administered as directed by the President for the purposes of this section.

RULES AND REGULATIONS

SEC. 209. The President is authorized to prescribe such rules and regulations as may be necessary to carry out the purposes of this title, and any violation of any such rule or regulation shall be punishable by fine of not to exceed $500 or imprisonment not to exceed six months, or both.

ISSUE OF SECURITIES AND SINKING FUND

SEC. 210. (a) The Secretary of the Treasury is authorized to borrow, from time to time, under the Second Liberty Bond Act, as amended, such amounts as may be necessary to meet the expenditures authorized by this Act, or to refund any obligations previously issued under this section, and to issue therefor bonds, notes, certificates of indebtedness, or Treasury bills of the United States.

(b) For each fiscal year beginning with the fiscal year 1934 there is hereby appropriated, in addition to and as part of, the cumulative sinking fund provided by section 6 of the Victory Liberty Loan Act, as amended, out of any money in the Treasury not otherwise appropriated, for the purpose of such fund, an amount equal to 2½ per centum of the aggregate amount of the expenditures made out of appropriations made or authorized under this Act as determined by the Secretary of the Treasury.

REEMPLOYMENT AND RELIEF TAXES

SEC. 211. (a) Effective as of the day following the date of the enactment of this Act, section 617 (a) of the Revenue Act of 1932 is amended by striking out "1 cent" and inserting in lieu thereof "1½ cents."

(b) Effective as of the day following the date of the enactment of this Act, section 617 (c) (2) of such Act is amended by adding at the end thereof a new sentence to read as follows: "As used in this paragraph the term 'benzol' does not include benzol sold for use otherwise than as a fuel for the propulsion of motor vehicles, motor boats, or airplanes, and otherwise than in the manufacture or production of such fuel."

SEC. 212. Titles IV and V of the Revenue Act of 1932 are amended by striking out "1934" wherever appearing therein and by inserting in lieu thereof "1935." Section 761 of the Revenue Act of 1932 is further amended by striking out "and on July 1, 1933" and inserting in lieu thereof "and on July 1, 1933, and on July 1, 1934."

SEC. 213. (a) There is hereby imposed upon the receipt of dividends (required to be included in the gross income of the recipient under the provisions of the Revenue Act of 1932) by any person other than a domestic corporation, an excise tax equal to 5 per centum of the amount thereof, such tax to be deducted and withheld from such dividends by the payor corporation. The tax imposed by this section shall not apply to dividends declared before the date of the enactment of this Act.

(b) Every corporation required to deduct and withhold any tax under this section shall, on or before the last day of the month following the payment of the dividend, make return thereof and

pay the tax to the collector of the district in which its principal place of business is located, or, if it has no principal place of business in the United States, to the collector at Baltimore, Maryland.

(c) Every such corporation is hereby made liable for such tax and is hereby indemnified against the claims and demands of any person for the amount of any payment made in accordance with the provisions of this section.

(d) The provisions of sections 115, 771 to 774, inclusive, and 1111 of the Revenue Act of 1932 shall be applicable with respect to the tax imposed by this section.

(e) The taxes imposed by this section shall not apply to the dividends of any corporation enumerated in section 103 of the Revenue Act of 1932.

SEC. 214. Section 104 of the Revenue Act of 1932 is amended by striking out the words "the surtax" wherever occurring in such section and inserting in lieu thereof "any internal-revenue tax." The heading of such section is amended by striking out "surtaxes" and inserting in lieu thereof "internal-revenue taxes." Section 13(c) of such Act is amended by striking out "surtax" and inserting in lieu thereof "internal-revenue tax."

SEC. 215. (a) For each year ending June 30 there is hereby imposed upon every domestic corporation with respect to carrying on or doing business for any part of such year an excise tax of $1 for each $1,000 of the adjusted declared value of its capital stock.

(b) For each year ending June 30 there is hereby imposed upon every foreign corporation with respect to carrying on or doing business in the United States for any part of such year an excise tax equivalent to $1 for each $1,000 of the adjusted declared value of capital employed in the transaction of its business in the United States.

(c) The taxes imposed by this section shall not apply—

(1) to any corporation enumerated in section 103 of the Revenue Act of 1932;

(2) to any insurance company subject to the tax imposed by section 201 or 204 of such Act;

(3) to any domestic corporation in respect of the year ending June 30, 1933, if it did not carry on or do business during a part of the period from the date of the enactment of this Act to June 30, 1933, both dates inclusive; or

(4) to any foreign corporation in respect of the year ending June 30, 1933, if it did not carry on or do business in the United States during a part of the period from the date of the enactment of this Act to June 30, 1933, both dates inclusive.

(d) Every corporation liable for tax under this section shall make a return under oath within one month after the close of the year with respect to which such tax is imposed to the collector for the district in which is located its principal place of business or, if it has no principal place of business in the United States, then to the collector at Baltimore, Maryland. Such return shall contain such information and be made in such manner as the Commissioner with the approval of the Secretary may by regulations prescribe. The tax shall, without assessment by the Commissioner or notice from the collector, be due and payable to the collector before the expiration of the period for filing the return. If the tax is not paid when due, there shall be added as part of the tax interest at the rate of 1 per centum a month from the time when the tax became due until paid. All provisions of law (including penalties) applicable in respect of the taxes imposed by section 600 of the Revenue Act of 1926 shall, insofar as not inconsistent with this section, be applicable in respect of the taxes imposed by this section. The Commissioner may extend the time for making the returns and paying the taxes imposed by this section, under such rules and regulations as he may prescribe with the approval of the Secretary, but no such extension shall be for more than sixty days.

(e) Returns required to be filed for the purpose of the tax imposed by this section shall be open to inspection in the same manner, to the same extent, and subject to the same provisions of law, including penalties, as returns made under title II of the Revenue Act of 1926.

(f) For the first year ending June 30 in respect of which a tax is imposed by this section upon any corporation, the adjusted declared value shall be the value, as declared by the corporation in its first return under this section (which declaration of value cannot be amended), as of the close of its last income-tax taxable year ending at or prior to the close of the year for which the tax is imposed by this section (or as of the date of organization in the case of a corporation having no income-tax taxable year ending at or prior to the close of the year for which the tax is imposed by this section). For any subsequent year ending June 30, the adjusted declared value in the case of a domestic corporation shall be the original declared value plus (1) the cash and fair market value of property paid in for stock or shares, (2) paid-in surplus and contributions to capital, and (3) earnings and profits, and minus (A) the value of property distributed in liquidation to shareholders, (B) distributions of earnings and profits, and (C) deficits, whether operating or nonoperating; each adjustment being made for the period from the date as of which the original declared value was declared to the close of its last income-tax taxable year ending at or prior to the close of the year for which the tax is imposed by this section. For any subsequent year ending June 30, the adjusted declared value in the case of a foreign corporation shall be the original declared value adjusted, in accordance with regulations prescribed by the Commissioner with the approval of the Secretary, to reflect increases or decreases (for the period specified in the preceding sentence) in the capital employed in the transaction of its business in the United States.

(g) The terms used in this section shall have the same meaning as when used in the Revenue Act of 1932.

SEC. 216. (a) There is hereby imposed upon the net income of every corporation, for each income-tax taxable year ending after the close of the first year in respect of which it is taxable under section 215, an excess-profits tax equivalent to 5 per centum of such portion of its net income for such income-tax taxable year as is in excess of 12½ per centum of the adjusted declared value of its capital stock (or in the case of a foreign corporation the adjusted declared value of capital employed in the transaction of its business in the United States) as of the close of the preceding income-tax taxable year (or as of the date of organization if it had no preceding income-tax taxable year) determined as provided in section 215. The terms used in this section shall have the same meaning as when used in the Revenue Act of 1932.

(b) The tax imposed by this section shall be assessed, collected, and paid in the same manner, and shall be subject to the same provisions of law (including penalties), as the taxes imposed by title I of the Revenue Act of 1932.

SEC. 217. (a) The President shall proclaim the date of—

(1) the close of the first fiscal year ending June 30 of any year after the year 1933, during which the total receipts of the United States (excluding public-debt receipts) exceed its total expenditures (excluding public-debt expenditures other than those chargeable against such receipts), or

(2) the repeal of the eighteenth amendment to the Constitution,

whichever is the earlier.

(b) Effective as of the 1st day of the calendar year following the date so proclaimed section 617(a) of the Revenue Act of 1932, as amended, is amended by striking out "1½ cents" and inserting in lieu thereof "1 cent."

(c) The tax on dividends imposed by section 213 shall not apply to any dividends declared on or after the 1st day of the calendar year following the date so proclaimed.

(d) The capital-stock tax imposed by section 215 shall not apply to any taxpayer in respect of any year beginning on or after the 1st day of July following the date so proclaimed.

(e) The excess-profits tax imposed by section 216 shall not apply to any taxpayer in respect of any taxable year after its taxable year during which the date so proclaimed occurs.

SEC. 218. (a) Effective as of January 1, 1933, sections 117, 23(i), 169, 187, and 205 of the Revenue Act of 1932 are repealed.

(b) Effective as of January 1, 1933, section 23(r) (2) of the Revenue Act of 1932 is repealed.

(c) Effective as of January 1, 1933, section 23(r) (3) of the Revenue Act of 1932 is amended by striking out all after the word "Territory" and inserting a period.

(d) Effective as of January 1, 1933, section 182(a) of the Revenue Act of 1932 is amended by inserting at the end thereof a new sentence as follows: "No part of any loss disallowed to a partnership as a deduction by section 23(r) shall be allowed as a deduction to a member of such partnership in computing net income."

(e) Effective as of January 1, 1933, section 141(c) of the Revenue Act of 1932 is amended by striking out "except that for the taxable years 1932 and 1933 there shall be added to the rate of tax pre-

scribed by sections 13(a), 201(b), and 204(a), a rate of three fourths of 1 per centum" and inserting in lieu thereof the following: "except that for the taxable years 1932 and 1933 there shall be added to the rate of tax prescribed by sections 13(a), 201(b), and 204(a), a rate of three fourths of 1 per centum and except that for the taxable years 1934 and 1935 there shall be added to the rate of tax prescribed by sections 13(a), 201(b), and 204(a), a rate of 1 per centum."

(f) No interest shall be assessed or collected for any period prior to September 15, 1933, upon such portion of any amount determined as a deficiency in income taxes as is attributable solely to the amendments made to the Revenue Act of 1932 by this section.

(g) In cases where the effect of this section is to require for a taxable year ending prior to June 30, 1933, the making of an income-tax return not otherwise required by law, the time for making the return and paying the tax shall be the same as if the return was for a fiscal year ending June 30, 1933.

(h) Section 55 of the Revenue Act of 1932, is amended by inserting before the period at the end thereof a semicolon and the following: "and all returns made under this Act after the date of enactment of the National Industrial Recovery Act shall constitute public records and shall be open to public examination and inspection to such extent as shall be authorized in rules and regulations promulgated by the President."

SEC. 219. Section 500 (a) (1) of the Revenue Act of 1926, as amended, is amended by striking out the period at the end of the second sentence thereof and inserting in lieu thereof a comma and the following: "except that no tax shall be imposed in the case of persons admitted free to any spoken play (not a mechanical reproduction), whether or not set to music or with musical parts or accompaniments, which is a consecutive narrative interpreted by a single set of characters, all necessary to the development of the plot, in two or more acts, the performance consuming more than 1 hour and 45 minutes of time."

APPROPRIATION

SEC. 220. For the purposes of this Act, there is hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $3,300,000,000. The President is authorized to allocate so much of said sum, not in excess of $100,000,000, as he may determine to be necessary for expenditures in carrying out the Agricultural Adjustment Act and the purposes, powers, and functions heretofore and hereafter conferred upon the Farm Credit Administration.

SEC. 221. Section 7 of the Agricultural Adjustment Act, approved May 12, 1933, is amended by striking out all of its present terms and provisions and substituting therefor the following:

"SEC. 7. The Secretary shall sell the cotton held by him at his discretion, but subject to the foregoing provisions: *Provided*, That he shall dispose of all cotton held by him by March 1, 1936: *Provided further*, That, notwithstanding the provisions of section 6, the Secretary shall have authority to enter into option contracts with producers of cotton to sell to the producers such cotton held by him, in such amounts and at such prices and upon such terms and conditions as the Secretary may deem advisable, in combination with rental or benefit payments provided for in part 2 of this title.

"Notwithstanding any provisions of existing law, the Secretary of Agriculture may in the administration of the Agricultural Adjustment Act make public such information as he deems necessary in order to effectuate the purposes of such Act."

TITLE III—AMENDMENTS TO EMERGENCY RELIEF AND CONSTRUCTION ACT AND MISCELLANEOUS PROVISIONS

SECTION 301. After the expiration of ten days after the date upon which the Administrator has qualified and taken office, (1) no application shall be approved by the Reconstruction Finance Corporation under the provisions of subsection (a) of section 201 of the Emergency Relief and Construction Act of 1932, as amended, and (2) the Administrator shall have access to all applications, files, and records of the Reconstruction Finance Corporation relating to loans and contracts and the administration of funds under such subsection: *Provided*, That the Reconstruction Finance Corporation may issue funds to a borrower under such subsection (a) prior to January 23, 1939, under the terms of any agreement or any commitment to bid upon or purchase bonds entered into with such borrower pursuant to an application approved prior to the date of termination, under this section, of the power of the Reconstruction Finance Corporation to approve applications.

DECREASE OF BORROWING POWER OF RECONSTRUCTION FINANCE CORPORATION

SEC. 302. The amount of notes, debentures, bonds, or other such obligations which the Reconstruction Finance Corporation is authorized and empowered under section 9 of the Reconstruction Finance Corporation Act, as amended, to have outstanding at any one time is decreased by $400,000,000.

SEPARABILITY CLAUSE

SEC. 303. If any provision of this Act, or the application thereof to any person or circumstances, is held invalid, the remainder of the Act, and the application of such provision to other persons or circumstances, shall not be affected thereby.

SHORT TITLE

SEC. 304. This Act may be cited as the "National Industrial Recovery Act."

Public Works and Recovery

RECENT PASSAGE by Congress of the National Industrial Recovery Act (given in full in the preceding pages) and its approval by the President must indeed prove heartening to all engineers. Many who have closely followed the development of this movement are confident that the ability of public works to solve many economic problems will be strongly demonstrated in this large-scale effort.

Doubtless also the employment possibilities inherent in the undertaking will be brought home closely to many members. The obvious intent of this legislation, with its expenditure of three billions and more on public works, is that construction should be distributed largely within states, counties, cities, and the smaller governmental units. Such a tremendous outlay will demand the reemployment of many technical men. Of these, engineers, surveyors, estimators, and inspectors doubtless will come first to mind. But in addition it is confidently expected that this immense program will make itself felt beneficially in numberless ways, involving every industry and locality.

In spite of the fact that a considerable part of the work in all probability will be prosecuted through existing governmental agencies, it seems that the major emphasis will properly be placed on the smaller political units, such as towns and local communities. Hence engineers should be alive especially to the possibilities in their own localities. Such an attitude is directly in line with the intent of those administering the National Industrial Recovery Act.

National Color of the Eleventh Engineers

AT A SIMPLE yet impressive ceremony in the Board Room of the Society on June 15, 1933, the service national color of the Eleventh Engineer Regiment was presented to United Engineering Trustees, Inc., for permanent preservation. The presentation was made by Mrs. Parsons, wife of the late William Barclay Parsons, Hon. M. Am. Soc. C.E. General Parsons not only organized the regiment but commanded it during its service in France.

The Eleventh Engineers were the first armed American troops to arrive in England after the United States entered the War and were reviewed in London by the King and Queen in 1917. The regiment's first engagement was with the British at Cambrai.

In a case in the entrance lobby of the Engineering Societies Building, 33 West 39th Street, New York, are displayed the national and regimental colors of the Twenty-fourth and the Twenty-seventh Engineers and the 312th Signal Corps. The color of the Eleventh Engineers, entrusted to the safekeeping of the United Engineering Trustees, Inc., is now displayed in the same case, where it can be viewed by all who are interested.

News of Local Sections

BUFFALO SECTION

At a meeting of the Buffalo Section, held at the Buffalo Athletic Club on May 16, officers for the coming year were elected as follows: George F. Unger, President; Elwin G. Speyer, Vice-President; and Frederick O. Francis, Secretary-Treasurer.

CONNECTICUT SECTION

A meeting of the Connecticut Section, called principally for the purpose of discussing methods of stimulating public works, was held at the University Club in Hartford on May 23. Several interesting talks on unemployment were given. Among those who spoke were William Rankin, mayor of Hartford; Harrison P. Eddy, of Metcalf and Eddy, of Boston; and Frank A. Barbour, consulting engineer of Boston. There were 27 members and guests in attendance.

DAYTON SECTION

At noon on May 15, the regular monthly meeting of the Dayton Section was held at the Engineers Club. Nicholas Didishko, a young student from Russia, now a senior in the Engineering College of the University of Dayton, gave a talk on conditions in Russia. There were 19 present.

ITHACA SECTION

The Ithaca Section held a dinner meeting in Willard Straight Hall on the campus of Cornell University on April 18. Glenn D. Holmes, Chief Engineer of the Intercepting Sewer Board, of Syracuse, N.Y., was the guest speaker. He described the design and construction of the new activated sludge sewage treatment plant at Newark, N.Y. The May meeting of the Section, held on the 16th, was in conjunction with a meeting of the Cornell University Student Chapter. This joint session was addressed by Howard E. Whitney, Construction Engineer for the Pennsylvania Water and Power Company and the Safe Harbor Water Power Corporation.

KANSAS CITY SECTION

There were 32 in attendance at a dinner and meeting of the Kansas City Section held on May 16. The guest of honor was Col. F. G. Jonah, who addressed the meeting on engineering matters of general interest. The Section voted to affiliate with the recently formed Construction Council of Missouri.

LOUISIANA SECTION

The annual meeting of the Louisiana Section was held in New Orleans on May 10, with 51 members and guests present. Included in the business session was the election of officers for the ensuing year, which resulted as follows: John Riesa, President; John H. O'Neill, First Vice-President; F. P. Hamilton, Second Vice-President; H. A. Sawyer, Secretary; and R. L. Moroney, Treasurer. Among those who spoke were D. Derickson, Professor of Civil Engineering at Tulane University; Harold A. Stone, Director of Research for the California Taxpayers' Association; Allan T. Dusenbury, consulting engineer of New Orleans; and Charles Wiggin, president of the local section of the American Society of Mechanical Engineers.

MID-SOUTH SECTION

There were over 150 in attendance at the annual convention of the Mid-South Section, held in Vicksburg, Miss., on May 5 and 6. The guests of honor were Alonzo J. Hammond and Anson Marston, President and Past-President of the Society, respectively, and F. G. Jonah, Chief Engineer of the Frisco Lines. The election of officers for the coming year resulted as follows: T. B. Larkin, President; Herbert D. Vogel and H. W. Nugent, Vice-Presidents from Mississippi; C. E. Boesch and Vernon H. Smith, Vice-Presidents from Tennessee; W. D. Dickinson and W. W. Zass, Vice-Presidents from Arkansas; and C. H. Schwartz, Secretary-Treasurer. Included among the speakers were the following: Maj.-Gen. Lytle Brown, Chief of Engineers, U.S. Army; Brig.-Gen. Harley B. Ferguson, President of the Mississippi River Commission; T. B. Larkin, District Engineer, U.S. Engineer Office; and George R. Clemens, Senior Engineer, Mississippi River Commission. Other features of the occasion were inspection trips to the U.S. Waterways Experiment Station, the Vicksburg Bridge, and other points of engineering interest.

MILWAUKEE SECTION

On April 26 the Milwaukee Section held a meeting at the City Club, with 29 present. Various routine business matters occupied a part of the session. The speaker of the evening was Maj. Harry M. Trippe, of the U.S. Engineer Office, who gave an address on the subject of experimental breakwaters, illustrating his talk by means of three models of breakwaters of wood and concrete of the usual type of construction.

NORTHWESTERN SECTION

The Northwestern Section held a dinner meeting jointly with the University of Minnesota Student Chapter on May 25. The principal speaker of the occasion was George M. Shepard, Chief Engineer of the Department of Public Works of St. Paul, who chose for his subject, "Recent Federal Public Work and Emergency Unemployment Relief Measures." An interesting discussion of this topic followed Mr. Shepard's remarks.

Student Chapter News

COLUMBIA UNIVERSITY

The Columbia University Student Chapter and its guests enjoyed a spring party and dance at the Men's Faculty Club on April 21. The entertainment included motion pictures of surveying and mapping at Camp Columbia, music by the camp orchestra, and an illustrated lecture on prints on engineering subjects by J. K. Finch, Renwick Professor of Civil Engineering at the university. At the close of this program refreshments were served, and the rest of the evening was devoted to an informal dance.

RENSSELAER POLYTECHNIC INSTITUTE

There were about 150 in attendance at the March meeting of the Rensselaer Polytechnic Institute Student Chapter. The feature of the occasion was an address by Francis J. Keis, consulting engineer with Solomon and Keis of Troy, N.Y., whose topic was the development of an artesian water supply for the Latham Water District in Albany County, New York. Maps, slides, and motion pictures were used to illustrate this interesting lecture.

Appointments of Society Representatives

SAMUEL G. NEILER AND BION J. ARNOLD, Members Am. Soc. C.E., served as Society representatives at the summer meeting of the American Association for the Advancement of Science, held in Chicago, June 19–30.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

INDUSTRIAL CONTROL—PUBLIC WORKS LEGISLATION

HOPES of the engineering profession and the construction industry for a revival in construction activity seem well on the way to fulfillment through the enactment of the Adminstration's program providing for industrial control and a greatly expanded public works program. The full text of the measure appears elsewhere in this issue.

Title II, providing for public works and construction projects,

remains virtually unchanged from its original form. Briefly the bill provides for the preparation by an Administrator of Public Works of a comprehensive program of public works and for the financing of their construction with Federal funds. Government personnel has already been active for several weeks in shaping up the Federal construction plans to fit such a program. Emphasis is being placed on the consideration of those projects that can be started without delay.

Washington is the Mecca for unemployed engineers hoping to secure positions with the Public Works Administration. Well considered opinion indicates that in general the profession has greater opportunity of indirect employment through association with the municipal, county, state, and Federal agencies which will actually execute the public works projects contemplated under the act.

Title III virtually brings to an end the activities of the Reconstruction Finance Corporation relative to the granting of loans for self-liquidating projects. The act provides that after a period of ten days following its enactment, this work will be administered by the Federal Public Works Administration. Title I of the bill is of particular interest to industrial engineers because of its provisions for the stimulation of trade through trade agreements providing for fair competition.

FEDERAL EMPLOYMENT OF PRIVATE ENGINEERS

The recently enacted Industrial Control–Public Works Bill containing provisions for an expanded Federal public works program will result in a marked increase in the activities of the office of the Supervising Architect, Treasury Department. The Assistant Secretary of the Treasury in charge of Public Buildings, L. W. Robert, Jr., M. Am. Soc. C.E., has declared his desire to utilize to the fullest extent the services of private engineers and architects. He frankly states that he expects services of the highest character, and that they shall be rendered most expeditiously. He further states that he will carefully scrutinize the qualifications of architects and will insist that they employ or have associated with them engineers of high caliber to ensure that the engineering design of the buildings will be of the highest type. Mr. Robert has called upon the American Engineering Council and the American Institute of Architects to furnish him with lists of competent members of their professions in every state. It is not expected that the initial effort will result in an inclusive list. The Council will therefore continue to cooperate with the Treasury Department in bringing to its attention additional names and in investigating the qualifications of names that have reached the department from other sources.

This request on the part of the Assistant Secretary of the Treasury presents an opportunity for the engineering profession to render a difficult and valuable public service. It represents a confidence that can be sustained only by the willing and unselfish cooperation of members of the profession throughout the country. From Mr. Robert the engineers are assured of sympathetic understanding as he has devoted his entire business life to the practice of the profession. A graduate of the Georgia Institute of Technology, he has attained prominence throughout the South as president of Robert and Company, consulting engineers and architects of Atlanta, Ga. In addition to being a member of the American Society of Civil Engineers, Mr. Robert is a member of the Georgia State Board of Architects, the American Institute of Electrical Engineers, and the American Society of Mechanical Engineers.

TENNESSEE VALLEY AUTHORITY

With the President's signing of H.R. 5081 on May 18, the Tennessee Valley Authority became an established fact after many years of controversy as to disposition to be made of the Government properties at Muscle Shoals. The act paves the way for the future development of the entire Tennessee River Basin. The bill accents the production and distribution of power, and the production of fertilizer has been subordinated to an experimental plane. The President is authorized to lease the Government Nitrate Plant at Muscle Shoals and if he fails to do so within one year, discretionary authority is granted the Tennessee Valley Authority for the limited production of fertilizer.

The measure carries authority for the immediate construction, by either the Secretary of War or the Secretary of Interior, of Cove Creek Dam and a transmission line connecting it with Muscle Shoals. The Authority is further empowered to build or lease lines for the transmission and distribution of power, to proceed with flood control work in the Tennessee Valley area, to improve the navigability of the Tennessee River, to undertake the prevention of soil erosion, and generally to provide for the agricultural and industrial development of the valley. The measure authorizes the issuance of bonds not to exceed $50,000,000 in amount, for the purpose of constructing any future dam, steam plant, or other facility, to be used in whole or in part for the generation or transmission of electric power. The measure further authorizes all appropriations necessary to carry out the provisions of the act.

The engineering profession has cause to be gratified at the President's selection of Arthur E. Morgan, M. Am. Soc. C.E., to be chairman of the Tennessee Valley Authority. Dr. Morgan is perhaps best known in engineering circles for his work as chief engineer of the Miami Conservancy District. In addition to his duties as President and Director of the Dayton Morgan Engineering Company, he has served as President of Antioch College, Yellow Springs, Ohio, since 1922.

The Senate on June 10 confirmed the appointments of H. A. Morgan, President, University of Tennessee, and David E. Lilienthal, Member, Wisconsin Railroad Commission, to fill the other two vacancies on the board of the Tennessee Valley Authority. Dr. H. A. Morgan has been intimately identified with industrial problems in Tennessee, and Mr. Lilienthal is noted for his experience in public utility regulation work in Wisconsin.

GOVERNMENT REORGANIZATION PLANS

Executive orders for reorganizing certain Government services, submitted to Congress June 10 by President Roosevelt, affect to some extent the technical services of the Government. These Executive orders were of a limited nature and conformed to a previous statement attributed to the President that he would not at this time attempt a complete reorganization of the Executive offices of the Government. Among other changes the orders provide for the following:

1. The consolidation of all functions of administering public buildings and reservations, national parks, national monuments, and national cemeteries in the Department of the Interior, and the abolition of the following commissions: Arlington Memorial Bridge Commission; Public Buildings Commission; Public Buildings and Public Parks of the National Capital; National Memorial Commission; and Rock Creek and Potomac Parkway Commission.
2. The abolition of the U.S. Shipping Board and the transfer to the Department of Commerce of its functions and those of the U.S. Shipping Board Merchant Fleet Corporation.
3. The abolition of the National Screw Thread Commission.
4. The abolition of the Federal Employment Stabilization Board.

In accordance with law, the orders are made to become effective 61 days from the date submitted to Congress, except that it is felt that some discretion must be reserved to postpone the effective date in the case of particular transfers.

SUPREME COURT ORDERS COMPLIANCE WITH LAKE WATER DECREE

The Supreme Court of the United States enlarged its decree in the so-called Chicago Lake Water Diversion case, on May 22, to require the State of Illinois to take all necessary steps, including provision for the appropriation of money, that may be required to comply with the decree of the court in the case. Chief Justice Hughes declared in his opinion that the state, and not the Sanitary District of Chicago, is the primary party responsible for the execution of the court's decree. The State of Illinois was told to report its action in compliance with this provision on or before October 2.

NEW MEMBER OF MISSISSIPPI RIVER COMMISSION

The Senate on May 18 confirmed the appointment of Leo O. Colbert, M. Am. Soc. C.E., as a member of the Mississippi River Commission. Commander Colbert's appointment to the commission is in accordance with the provision of the law which requires that one member of the board shall be from the U.S. Coast and Geodetic Survey. He fills the vacancy caused by the recent death of Capt. Robert L. Faris, former Assistant Director of the Coast and Geodetic Survey.

June 15, 1933

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for August

As THIS ISSUE leaves the presses, the Sixty-third Annual Convention of the Society at Chicago is in full swing. A number of its sessions are being held jointly with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Academy for the Advancement of Science. The program bristles with valuable contributions.

For the benefit of those who are unable to go to the Convention and as a record for those who attend, the papers presented are to be abstracted in the next two issues of CIVIL ENGINEERING—those for August and September. In the August number will be found the papers presented at the general session on Tuesday, June 27, 1933, and at the meetings of the Technical Divisions held on Thursday, June 29.

Every taxpayer, every citizen, and every engineer must be interested in rising taxes. A feature of the general technical meeting on Tuesday, June 27, was a round-table discussion on tax reduction in cities, states, and the National Government. Arranged under the auspices of the Engineering-Economics and Finance Division, this part of the Convention program indicates definitely that the members of the profession will be able to help considerably in straightening out the snarl of overlapping taxes and their increasing burden. The August issue of CIVIL ENGINEERING will contain abstracts of the papers presented at this meeting.

One of the features of the session on Thursday is the review by the Construction Division of the progress made during the past century in construction methods. Twelve engineers, each an expert in his special branch of the profession, present brief papers pointing out the advances made in methods and materials in the construction of transportation facilities, bridges, municipal facilities, Federal reclamation projects, national defense facilities, water terminals, construction machinery, and industrial buildings.

Engineers specializing in hydraulics and power will be interested in the report of the Committee on Legislation Respecting the Safety of Dams and in the analysis of the official plans presented for the development of the international section of the St. Lawrence River. A paper on the Chicago terminus of the Lakes-to-Gulf Waterway will give an insight into the influence of water-borne transportation on this great commercial center of the Middle West. In addition to these papers, the August issue will contain abstracts of those presented at the Thursday meetings of the Structural, the Surveying and Mapping, and the Highway Divisions. The September number is being reserved for abstracts of the papers read before the Technical Divisions on Friday, June 30, 1933.

Engineering Progress Depicted by Models

REPRESENTATIVE of the splendid display work being done by Student Chapters of the Society, and by undergraduate civil engineering classes in general throughout the country, are the models displayed at the last "open-house" of Iowa State College, at Ames, Iowa. Some of these are shown in the accompanying illustrations.

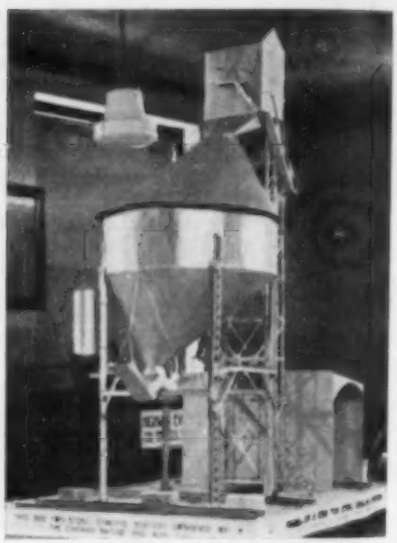
COLORADO RIVER PROJECT IN MODELS

The George Washington Bridge, built from drawings included in the first progress report of the Port of New York Authority, served as the subject for a float in the college's annual Veishea Parade last May. This model, built to scale and having an over-all length of 20 ft, gave a very pleasing effect and afforded an accurate representation of the actual structure. It was awarded first prize in the engineering group and the second all-college prize.

Among the models representing the work of the civil engineer at the open-house exhibit were those depicting the Boulder Dam, highway evolution, stream pollution, and a coaling station, all built under the leadership of the Student Chapter of the Society. Two of these models are pictured.

In the background of the illustration showing the Boulder Dam model can be seen a large relief map giving the important topographic features of the entire flood-control, water-supply, and power-development project. Explanatory notes emphasizing the magnitude of the project accompanied this exhibit.

All the structural parts of the coaling station model were made from paper, including the latticed girders, angles, gussets, and sheet-steel plates. A coat of aluminum paint gave these parts and the finished model a realistic appearance.



300-TON STEEL COALING STATION
Paper Model from Working Drawings

The model, which measured 18 by 24 in. in plan and 30 in. in height, was built from blueprints used several years ago

DEPARTMENT OF CIVIL ENGINEERING
GEORGE WASHINGTON MEMORIAL BRIDGE OVER THE HUDSON RIVER
The Outstanding Engineering Achievement of 1932
Distance Between Towers-3500 ft. Height of Towers-650 ft.
IOWA STATE COLLEGE
VEISHEA 1932

MODEL OF GEORGE WASHINGTON BRIDGE USED AS A FLOAT

in erecting the full-sized structure for the Chicago, Rock Island, and Pacific Railway, at Manly, Iowa. About 30 students of the freshman class participated in the work as a study in descriptive geometry. Thus they were acquainted with working drawings, structural shapes, and design and erection procedure.

Degrees Conferred on Engineers

AS IS USUAL at commencement time, universities and colleges throughout the country are taking cognizance of the importance of the engineer's contribution to science by conferring honorary and advanced degrees on numerous members of the profession. Several members of the Society are among the engineers who have been thus honored during the 1933 commencement season. In addition to the following list there are probably others regarding whom information has not yet reached Society Headquarters.

LINCOLN ELLSWORTH, Assoc. M. Am. Soc. C.E., Master of Science, Yale University.

ALONZO J. HAMMOND, President Am. Soc. C.E., Doctor of Engineering, Rose Polytechnic Institute.

D. C. HENNY, M. Am. Soc. C.E., Doctor of Engineering, Oregon State College.

OTIS E. HOVEY, M. Am. Soc. C.E., Doctor of Science, Clarkson College of Technology.

WILLIAM S. MENDEN, M. Am. Soc. C.E., Doctor of Engineering, Rose Polytechnic Institute.

GEORGE R. PUTNAM, M. Am. Soc. C.E., Doctor of Engineering, Rose Polytechnic Institute.

ROBERT RIDGWAY, Past-President Am. Soc. C.E., Doctor of Engineering, Brooklyn Polytechnic Institute.

WALTER M. SMITH, M. Am. Soc. C.E., Doctor of Science, Military College of South Carolina.

Recent Honors Awarded

AMONG those receiving special engineering honors at this time are the following members of the Society:

D. C. HENNY, M. Am. Soc. C.E., has been elected an Honorary Member of the Royal Institute of Engineers (of Holland).

LEON S. MOISSEIFF, M. Am. Soc. C.E., has received the Louis Edward Levy Gold Medal award by the Franklin Institute of Philadelphia for his paper, "The Design, Materials, and Erection of the Kill Van Kull (Bayonne) Arch," published in the May 1932 issue of the Journal of the Franklin Institute. The award was made on May 17 at the annual Medal Day exercises of the institute.

To the Engineering Graduate of 1933

By E. P. ARNESON, M. AM. SOC. C.E.
PRESIDENT OF THE TEXAS SECTION OF THE SOCIETY

Reprinted from the May Issue of "The Texas Engineer," the Monthly Publication of the Texas Section

THE ENGINEERING graduate of 1933, in search of employment, must face an almost desperate competition from the older men. A large number of qualified engineers, many years out of college and with families, are in need of work. The young engineer is therefore likely to be unemployed for some time.

This is not news to the 1933 graduate. He is perhaps now filled with despair and disgust over the apparently barren outcome of four years of earnest college work. It is to the disappointed graduating engineer that the following is addressed.

Aside from its utilitarian aspect, engineering, soberly interpreted, presents a philosophy. If the young engineer has learned anything from his studies, it is surely the great general law of cause and effect with constant change. Things do not merely happen: there are reasons why they happen. Nor do things stay long in one condition. All nature proclaims this law, human nature no less. It ought to be plain then that the present economic depression is a social phenomenon. The depression is an observation, so to speak, made in a great laboratory and plotted on a graph of human progress somewhat below the average line of increase.

Only the unscientific believe the world will come to an end at an early date. The engineer knows it wobbles occasionally, but its average movement is the same from year to year. So it is with virile nations: they do not have meteoric careers. Even Rome had a long decline before it fell. There is some doubt that it ever truly fell. The United States is too strong to be permanently injured even by a major economic disturbance. The trend of its growth, again considered as a curve, has not flattened out. There are great days ahead for the American people.

All this a young engineer should be able to interpret from his own scientific experience. The question then is: What should he do under the circumstances? The answer is more study. If the 1933 graduate can finance further work at college, let him by all means do so. If this is not possible, let him study at home. To do this will be a graceful gesture toward a stricken profession, because he will remove himself from an unfortunate competition for employment.

If the 1933 graduate is bored with his studies and does not relish additional schooling therein, let him take up studies outside of engineering: drawing, music, foreign languages, literary effort. Engineers often progress in their own profession, strange to say, more by what they know outside of it than by what they know within it. Test the truth of this statement by asking older engineers.

Such, then, is the writer's program for the 1933 engineering graduate. First, let him draw on his own philosophy for interpreting present economic conditions, for comfort, and for confidence in his country. Then let him prepare himself in the amenities of life so that when the bright dawn appears, he may step out into it, not only as a good engineer, but as the complete man.

Bridges on Postage Stamps

STAMPS BEARING illustrations of bridge structures have been issued by countries throughout the world, as may be seen from the specimens reproduced on the page of special interest in this issue. A glance at the various countries represented will show that bridges evidently have universal popularity.

The first ten stamps, with the exception of No. 9, show what might perhaps be called the early types of bridges, including several with masonry arches. The stamp showing a railroad bridge wrecked by flood, No. 11, was issued by Liechtenstein in connection with a flood relief campaign, and all the stamps of the issue were sold at a premium, which was used for the relief fund.

The whole story of the increasing boldness with which engineers have designed bridges to span greater and greater widths is illustrated by these stamps. Here are shown the masonry arch of the ancients, the bamboo suspension bridge of a primitive people, modern reinforced concrete viaducts, far-flung steel arches, and cantilever and suspension spans—the product of the highest skill of today's builders.

It is evident that many countries consider even an ordinary bridge as a national achievement worthy of commemoration. A bridge so commemorated must have some special significance in the country where the stamp is issued. It would be of interest to discover the story behind each of these structures and their relation to the history of the country itself. In the United States and Canada, where some of the largest and most outstanding bridges have been constructed, only two examples of bridge work—the Niagara arch and the Quebec Bridge—have been commemorated by stamp issues.

The set of stamps reproduced in this number is from the collection of E. M. Proctor, M. Am. Soc. C.E., which contains stamps illustrating engineering works, such as power houses, dams, mines, mills, canals, and buildings. Although the originals from which the halftone reproduction was made are perfect specimens of uncanceled stamps, each engraving has been defaced by a white score line to comply with U.S. postal regulations.

An Adventure in Adult Education

SINCE NOVEMBER 1932 the local committee caring for unemployed engineers in metropolitan New York, that is, the Professional Engineers' Committee on Unemployment, has cooperated with The Engineering Foundation in conducting a series of courses at 33 West 39th Street, New York, for these unemployed engineers. The courses were given by members of the faculties of Columbia and New York universities, the Polytechnic Institute of Brooklyn, Stevens Institute of Technology, the College of the City of New York, and the Personnel Research Foundation. Six hundred engineers availed themselves of the opportunity to obtain without cost new viewpoints and mental occupation during this period of readjustment.

Classes were held twice a week and continued for from eight to twenty weeks. Ten courses were provided: in Business Finance, Building Construction, Concrete Design, Development of Inventions, Industrial Application of Electricity, Industrial Management, Mechanical Equipment of Buildings, Power Plant Engineering, Sales Engineering, and Vocational Readjustment.

One of the by-products of the courses was the obtaining of suggestions and criticisms from the registrants by means of a questionnaire distributed among them. Many bore witness to the high quality of the instruction given and to the value of the courses in building up their morale and broadening their outlook both on life and on the profession. In reply to the question as to what they considered were the deficiencies in their own college training, many of the older men expressed regret that they had not had courses in public speaking, economics, business finance, accounting, psychology, and sales engineering, and that their college courses had not been more cultural.

New Connectors for Timber

A METHOD of increasing the strength of wooden joints in timber construction from 4 to 8 times that obtained by the usual bolted connections is described in a printed report of the U.S. Department of Commerce, "Modern Timber Connectors for Timber Construction." The connectors consist of dowels and metallic rings of various types, which are set or forced into the wood concentric with the connecting bolt. This new type of construction for timber bridges is a development of the World War. Subsequently it was further developed in Europe and is now coming into use in the United States.

The 150-page report, which is the joint effort of the National Committee on Wood Utilization and the Forest Products Laboratory, may be secured from the Superintendent of Documents, Washington, D.C., at the price of 15 cents. It may also be obtained from the District Offices of the U.S. Department of Commerce, located in the principal cities of the country.

NEWS OF ENGINEERS

From Correspondence and Society Files

PAUL W. BAKER has accepted a position as Assistant Construction Engineer for the Metropolitan Utilities District, of Omaha, Nebr. He was previously employed as an assistant in the Water Resources Survey of the University of Nebraska.

G. H. ALLEN has resigned his position as Chief Designing Engineer for the International Steel Company, of Evansville, Ind., to become District Engineer of the Fifth District for the State Highway Commission, with headquarters in Vincennes, Ind.

C. Y. HOU, who was formerly Division Engineer for the Hangchow-Kiangshan Railway, with headquarters in Hangchow, China, has now accepted a position in the Department of Public Works of Nanking Municipality. He is located in Nanking.

HAROLD A. STONE has now accepted a connection as Executive Secretary with the Bureau of Governmental Research, with headquarters in New Orleans, La. He was formerly employed as Director of Research for the California Taxpayers' Association.

JAMES G. STEESE, since his return from Alaska last summer, has been located in Tulsa, Okla., as President of the Nortorp Corporation. He is also receiver for the White Oak Corporation, successor to the White Oak Refining Company, the White Oak Gasoline Company, and the Gulf States Terminal and Transport Company.

RICHARD HARRY HULL, formerly a draftsman for the Ventura Fuel Company, of Ventura, Calif., has accepted a position as Division Engineer with the Industrial Fuel Supply Company, of Los Angeles.

JULIO E. MEJIÁ has resigned as Dean of the Engineering School of the University de El Salvador, San Salvador, in order to take up the private practice of engineering. He will, however, retain the professorship of hydraulics.

A. B. CHRISTENSEN has resigned his position as Office Engineer for John Monks and Sons–Ulen and Company, Serres, Greece, to accept a connection with Kampmann, Saxild and Company, of Teheran, Persia.

JEPTHA A. WADE has severed his connection with the Federal Water Service Corporation, of New York, N.Y., to become Chief Engineer of the California Water Service Company, with headquarters in San Francisco.

S-C. KANG has resigned his position as Chief of the First Division of the Board of Public Works, of the Kiangsu Provincial Government, Chin Kiang, China, to become Chief of the Engineering Division of the Bureau of Public Roads for the National Economic Council of China, Nanking, China.

PAUL F. GEMPERLE has accepted a position with the Metropolitan Water District of Southern California, with offices in Los Angeles. He was formerly Assistant Engineer for J. B. Lippincott, of the same city.

H. E. MICHAUD has entered the employ, as engineer, of the Compania Manufacturera de Cigarros, "El Aguila," S. A. Nogal, No. 212, Mexico, D. F. Mexico, a subsidiary of the British-American Tobacco Company.

JOHN A. VEECH has accepted a position as Assistant Engineer of the Dawson Daylight Coal Company, Inc., of Louisville, Ky.

RALPH C. SWEENEY has accepted an appointment as Engineer of Sewerage and Sewage Treatment, in the Department of Public Works and Utilities of Springfield, Ohio.

EDWARD E. WALL has been reappointed to his former position as Director of Public Utilities of the City of St. Louis.

J. A. HERKOMER has resigned his position as instrumentman and assistant engineer with the Pacific Gas and Electric Company of Auburn, Calif., to become an inspector for the Los Angeles County Flood Control District on the San Gabriel Dam No. 1.

C. B. KIMBERLY has resigned as District Engineer for the U.S. Fidelity and Guaranty Company, of Baltimore, Md., to join the staff of Harris and Koontz, of Kansas City, Mo.

BAXTER L. BROWN, consulting engineer of St. Louis, Mo., has been appointed President of the Board of Public Service of St. Louis.

T. W. OSGOOD, formerly Assistant Superintendent of the California Industrial Accident Commission, of Los Angeles, Calif., has been appointed Safety Engineer of the Metropolitan Water District of Southern California, with headquarters in Banning, Calif.

JOHN H. WOULFE FLANAGAN has left his position with Messrs. Sheard Breach and Company, of London, to accept a connection in the Resident Engineer's Office on the Swansea Main Drainage Scheme, Swansea, Great Britain.

A. R. B. EDGECOMBE has joined the staff of the P. W. D. (Irrigation) Secretariat, of Lucknow, U. P., India.

J. NORMAN PEASE has resigned as Director of Lockwood, Greene Engineers, Inc., of New York, N.Y., to enter the employ of the Sardik Laboratories Inc., of the same city.

LUTHER W. IRWIN has accepted an engineering position with the Metropolitan Water District of Southern California. His headquarters will be Los Angeles.

S. R. TRUESDELL, formerly with the General Motors Truck Company, of Pontiac, Mich., is now with the Atlantic Greyhound Lines. His offices are in Charleston, W.Va.

C. L. CLARK has become associated with the Pennsylvania Department of Highways, with headquarters in Hollidaysburg, Pa. His former connection was with the Blair Home Company, of Altoona, Pa.

CHARLES C. ENGLISH is now associated with Sanitary Engineers, Inc., with headquarters in Cleveland, Ohio.

J. W. DAVIS has been promoted from the position of contracting engineer to that of contracting manager of the McClintic-Marshall Corporation, of St. Louis, Mo.

WILLIAM H. WICK has become associated with the Metropolitan Park Board of Tacoma, Wash., as Park Engineer.

CHARLES P. RICHMOND, previously employed as track supervisor for the New York, New Haven, and Hartford Railroad Company, has been made a transitman in the engineering department of this company.

J. S. MEANS has been promoted to the position of district engineer of the Johns-Manville Sales Corporation, of Cincinnati, Ohio.

F. D. HOWELL has opened a consulting office in Los Angeles, Calif. Previously he was with the Motor Transit Company of that city as Vice-President and General Manager.

FRANCISCO GOMEZ-PEREZ, who has been employed as Construction Manager of the Rodríguez Dam, Tijuana, Baja California, has now been promoted to the Mexico City office of the Mexican National Irrigation Commission.

GUY BOSCHKE, formerly with the Panama Mail Steamship Company of San Francisco, Calif., has now accepted the position of Vice-President of the Lineas Grace de Mexico, with headquarters in Mexico City.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From May 10 to June 9, 1933, Inclusive

ADDITIONS TO MEMBERSHIP

BECHTEL, GEORGE MITCHELL (Jun. '32), Liberty, Kans.

BISSELL, EARL CHALFANT (Assoc. M. '33), 5814 Fleming Ave., Oakland, Calif.

CATTIE, NICHOLAS JULIUS (Jun. '32), 601 Sixty-Fifth Ave., Oak Lane, Philadelphia, Pa.

ELLIOT, SIMON FRANK (Jun. '33), 2304 Grand Ave., Pueblo, Colo.

EVANS, SAMUEL ANTHONY (Assoc. M. '33), Junior Civ. Engr., Dept. of Water and Power (Res., 1438 North Coronado St.), Los Angeles, Calif.

FOLGNER, ARTHUR MAXWELL (Jun. '33), 502 West 213th St., New York, N.Y.

GATLIN, ROBERT HENRY (Jun. '33), Instr., Civ. Eng., Duke Univ., Box 294, College Station, Durham, N.C.

GEYER, JOHN CHARLES (Jun. '33), 7 Scott St., Cambridge, Mass.

GUERNSEY, EDWARD ELBRIDGE (Jun. '32), 28 Academy St., Arlington, Mass.

LAVERGNE YORDÁN, LUIS (Jun. '33), Treas., Earl K. Burton, Inc., Box 1367, San Juan, Puerto Rico.

LAYTON, WILLARD ALLEN (Jun. '32), Box 98, Morris, Conn.

LAZAR, DANIEL MORRISON (Jun. '33), Engr., Triest Contr. Corporation, 165-11 Hillside Ave., Jamaica (Res., 215 West 91st St., New York), N.Y.

LEVAN, STEPHEN (Jun. '32), 1706 South Meridian St., Indianapolis, Ind.

MACKENZIE, LEONARD ALEXANDER (Assoc. M. '32), Res. Engr., Clanwilliam Irrig. Works, Clanwilliam, Cape Province, Union of South Africa.

MANLEY, RICHARD GEORGE (Assoc. M. '33), City Service Mgr., 240 East 9th St., Upland, Calif.

MARTIN, JOHN LEONARD (Assoc. M. '32), Supt. of Track, Philadelphia Rapid Transit Co. (Res., 6736 Ogontz Ave.), Philadelphia, Pa.

MOSKOWITZ, ISADORE (Jun. '32), 8518 Eighty-Ninth Ave., Woodhaven, N.Y.

NARIMAN, RUSTUM KAIKHUSHRO (M. '33), Prof. of Eng., Osmania Univ.; Gulistan, Sappers Lines, Secunderabad, India.

RIDDICK, THOMAS MOORE (Jun. '32), Instr., Hydr. and San. Eng., New York Univ., University Heights, New York, N.Y.

SPRINGER, REID CRAIGO (Assoc. M. '33), 49 Lexington Ave., New York, N.Y.

STUBBS, HENRY FRANKLIN (Assoc. M. '33), with Ouilmette Constr. & Eng. Co., Box 423, Alma, Wis.

THOMPSON, JOHN CAVETT (Jun. '33), Tracer, Middle Rio Grande Conservancy Dist. (Res., 1101 West Marquette Ave.), Albuquerque, N.Mex.

WILLIAMS, JAMES PATRICK (Assoc. M. '33), Sales and Service Engr., Alpha Portland Cement Co., 230 Park Ave., New York, N.Y. (Res., 211 Henry St., Hasbrouck Heights, N.J.)

MEMBERSHIP TRANSFERS

BROWN, DALTON MUNROE (Jun. '27; Assoc. M. '33), Engr., Marcus Contr. Co., Inc., 150 Nassau St., New York (Res., 1100 Ocean Ave., Apartment 4H, Brooklyn), N.Y.

CLARK, CHARLES SAMUEL (Assoc. M. '23; M. '32), with Surety Dept., Massachusetts Bonding & Insurance Co., 14 Kilby St., Boston, Mass.

COVAS, PERFECTO ANTONIO (Jun. '30; Assoc. M. '33), Computer, Div. of Design and Heavy Constr., City of Rochester (Res., 15 Meriden St.), Rochester, N.Y.

FELDMANN, EDWARD HENRY (Jun. '27; Assoc. M. '33), Asst. Engr., W. W. Young (Res., 58 De Kalb Ave.), White Plains, N.Y.

GEIGER, CHARLES DAVID (Jun. '30; Assoc. M. '33), Asst. Engr., Wm. Ferguson, 152 Market St. (Res., 161 North 9th St.), Paterson, N.J.

HUNTER, RALPH WALDO (Assoc. M. '25; M. '33), U.S. Veterans Hospital, Oteen, N.C.

KUHNS, JOHN DANIEL (Jun. '27; Assoc. M., '33), Business Mgr., Board of Education (Res., 254 West 3d St.), Springfield, Ohio.

LOTHES, HERBERT GEORGE (Jun. '29; Assoc. M. '33), Gen. Supt. of Constr., The Kroger Grocery & Baking Co. (Res., 2371 Rohs St.), Cincinnati, Ohio.

LUBKE, WALTER FRIEDRICH (Jun. '26; Assoc. M. '33), Constr. Mgr., Louis Keil, Ossining (Res., 95 Beekman Ave., Apartment 544 U, North Tarrytown), N.Y.

TOTAL MEMBERSHIP AS OF JUNE 9, 1933

Members	5,796
Associate Members	6,325
Corporate Members	12,121
Honorary Members	18
Juniors	2,979
Affiliates	113
Fellows	5
Total	15,236

RAMIREZ, REINALDO (Assoc. M. '23; M. '33), Chf. Asst. Engr., Am. R. R. of Puerto Rico, Box 330, San Juan, Puerto Rico.

SCHLENZ, HARRY EDWARD (Jun. '30; Assoc. M. '33), Engr. and Sales Mgr., Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

TSAI, FANG-YIN (Jun. '27; Assoc. M. '33), Prof., Dept. of Civ. Eng., National Tsing Hua Univ., Peiping, China.

REINSTATEMENTS

INFANTE, PERCIVAL MAXIMILIAN, M., reinstated May 15, 1933.

RESIGNATIONS

CHANDLER, JOHN HENRY, Assoc. M., resigned May 31, 1933.

DONOVAN, GREENSBURY WILLIAM, JR., Jun., resigned May 20, 1933.

HARTMANN, ROLF FOUGNER, Assoc. M., resigned May 31, 1933.

O'ROURKE, JAMES FRANCIS, Assoc. M., resigned May 10, 1933.

DEATHS

COLE, JOHN ADAMS. Elected M., Mar. 7, 1894; died Nov. 16, 1932.

DOREMUS, ABRAHAM FAIRBANKS. Elected M., Oct. 4, 1893; died May 10, 1933.

FERREBEE, HARRY HILBERT. Elected Assoc. M., July 11, 1927; died April 8, 1933.

GOINES, LAURENCE ARCHIBALD. Elected Assoc. M., Nov. 26, 1923; M., May 12, 1930; died December 18, 1932.

GREAVES, ANDREW VALERIAN. Elected Jun., June 7, 1926; Assoc. M., Aug. 26, 1929; died Jan. 25, 1932.

MAURY, DABNEY HERNDON. Elected M., May 3, 1899; died May 11, 1933.

NORTZLI, FRED ADOLPH. Elected Assoc. M., Nov. 25, 1919; M., July 12, 1926; died May 24, 1933.

PAGE, WILLIAM NELSON. Elected M., May 3, 1905; died March 7, 1932.

REDMAN, DWIGHT RAYMOND. Elected M., Aug. 30, 1926; died May 15, 1933.

SIMPSON, ROBERT HARRIS. Elected M., April 18, 1927; died May 18, 1933.

STEENSTRUP, PAUL. Elected Assoc. M., Oct. 1, 1926; died May 16, 1933.

WILSON, HENRY HARRISON. Elected Assoc. M., Nov. 26, 1918; M., July 16, 1928; died May 31, 1933.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1933 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Construction

Cost Engineer-Construction; Jun. Am. Soc. C.E.; 29; 5½ years on subsurface construction materials, steel erection, time studies, cost analysis, and estimating on subway work and cofferdam. D-2151.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 32; licensed construction engineer, New Jersey; 1 year of varied experience as draftsman and inspector; 2 years in charge of real estate development; 5 years on construction work and quantity surveying for estimating. Excellent references. Will consider connection with construction company or building inspector for valuation reports. D-1690.

Superintendent of Construction; M. Am. Soc. C.E.; experienced in bakery and brewery construction, handling all physical problems for either the owner's end or contractors. Able to take complete charge. C-7840.

Design

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; 35; New York State license; 10 years experience on building design, structural and mechanical equipment (heating, ventilating, etc.); designer of several all-welded buildings; instructor for 1 year in school for teaching design of welded steel structures. Available immediately. C-6369.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 37; married; graduate; state licenses; 10 years experience, surveying, design, and construction. Design, detail, and preparation of plans and specifications, on railroad, highway, parkway, harbor, and tall building structures. Completely familiar with the design of rigid-frame bridges. Available immediately. D-1496.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 30; married; graduate of Rensselaer Polytechnic Institute; licensed professional engineer and surveyor; 10 years experience—8 years with consulting engineer; 2 years in charge of office, designing steel and concrete bridges, fixed and movable, particularly vertical-lift, and steel and concrete for buildings; excellent draftsman. Salary secondary to demonstrating worth to employer. D-506.

Industrial Engineer and Architect; M. Am. Soc. C.E.; graduate; licensed; 20 years experience in the design and construction of industrial plants of all kinds, housing groups for private interests and state institutions, hydro-electric developments, etc. Experienced in organization and direction of drafting room and office forces, field forces. B-2835.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 30; married; graduate; 8 years experience in design of structural steel and reinforced concrete, mill buildings, blast furnaces, substations, transmission lines. Last 4 years in responsible charge of design and detail of electrification structures for railroad suburban electrification. Desires position with consulting engineer, fabricator, or engineering contractor. Available now. C-3326.

Executive

Civil Engineer; Assoc. M. Am. Soc. C.E.; 44; married; C.E. degree; 14 years highway engineering experience; qualified on estimates, designs, surveys, plans, specifications, and construction; 6½ years with Texas Highway Department—5½ years as resident engineer in charge of surveys, design, and construction, $1,700,000 county program. Desires responsible charge of work. Speaks Spanish. Available immediately. D-2178.

University Graduate; M. Am. Soc. C.E.; broad experience on surveys and investigations of conditions for construction; design and supervision of construction of water works, tunnels, and all kinds of large bridges of both steel and concrete, including the sinking of deep foundations by both the open sinking and under air methods; vigorous in mind and body. D-2170.

Civil Engineer; M. Am. Soc. C.E.; 49; licensed New York and Florida; 5 years on building construction, highways, and sewers; 20 years on dredging, rock removal, jetty construction, dike building, pile driving, bank revetment, and paving; economic studies; 5 years of field experience in above in direct charge. Location immaterial. Available immediately. C-3957.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 51; graduate; 28 years in responsible charge of construction and design of municipal water supply structures, locks, dams, reservoirs, river improvement, bridges, shafts, vehicular tunnel, irrigation canals and structures, etc. Qualified for an important position. Location and salary open. B-5412.

Civil Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, and transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

Civil Engineer; Jun. Am. Soc. C.E.; 29; married; college graduate with 4 years of experience and a year teaching-fellowship work. German descent; 68 inches tall; weighs 145 pounds; in good health; unemployed. Wishes connection with good company. Can give references. Available at once. Location United States or foreign. C-3977.

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; 9 years varied structural experience; drafting, design, surveys, and construction; also office and selling experience. Desires position in field or office in engineering or related business, in any capacity; also instructorship or sales-engineering. Available immediately. C-7605.

Construction Engineer and Superintendent; Assoc. M. Am. Soc. C.E.; 20 years experience, water works, sewers, municipal paving, and state road construction. Qualified to estimate, organize, and supervise. Surveys, reports, investigations, analysis, and financial connections made. Also available to any sales organization selling equipment or materials for this work. D-2203.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 34; 8 years experience in design, drafting, and construction of reinforced concrete, structural steel, and timber structures; developing and planning of paper and pulp plants. Location immaterial (foreign or domestic). Will do any professional work. Available now. D-119.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30 years experience, chiefly specializing in food markets, cold storage, refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

Civil Engineer; M. Am. Soc. C.E.; in South America for past 12 years in charge of various engineering and construction projects, which included heavy mountain railway construction, development and construction of subdivisions with all of its sewer, water, sidewalk, and pavement construction. Commercial and public building construction. Management of real estate projects. D-1992.

Structural Engineer; M. Am. Soc. C.E.; 45; married; extensive experience in fabricating business with exceptionally successful record in estimating, designing, and sales. Will appreciate opportunity to give further information in detail. C-5095.

Hydraulic Engineer; M. Am. Soc. C.E.; graduate; 23 years experience on irrigation, water supply, drainage, and river control; 8 years as chief engineer of irrigation districts, involving design and construction of large storage works; 2 years foreign consulting; ready for exacting work in field or office anywhere. Complete references. C-5225.

Junior

Graduate Engineer; Jun. Am. Soc. C.E.; 26; married; junior executive; 5 years experience, including estimating, structural design, architectural design, and real estate. Valuable supplementary experience in architecture. D-1743.

Junior Engineer; Jun. Am. Soc. C.E.; 26; married; architectural construction, Wentworth Institute, Boston, Mass., 1927; 6 years experience on bridge construction, surveys, estimates, inspection, and design, all types of concrete structures. Desires work of any sort. Location immaterial. D-2168.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; graduate of Ohio Northern State University, B.S. in C.E. Has had some experience in general engineering practice, especially surveying, with some topographic and construction work. Salary no object other than to make a living. Available immediately. Location immaterial. D-2177.

Civil Engineer; Jun. Am. Soc. C.E.; 22; single; B.S. in C.E., Bucknell University, 1932; desires position in any branch of civil engineering. Available immediately. Salary secondary. Location immaterial. D-2186.

Civil and Sanitary Engineer; 27; single; desires service in civil or sanitary engineering; Stanford University degrees, A.B. and engineer; 3 years graduate study and research in engineering, sanitation, chemistry, bacteriology, and biology. Construction, research, and teaching experience. Qualified for construction, design, laboratory, research, and teaching. Location immaterial. Immediately available. D-2191.

Transportation Engineer; Jun. Am. Soc. C.E.; 26; single; C.E. degree, Rensselaer Polytechnic Institute, 1928; at present Fellow in Transportation, Yale University, studying railway operation, regulation, accounting, and statistics; 4 years experience with Class I railroad on construction and maintenance of bridges, buildings, and track; also, surveys, estimates, engineering reports, and legal testimony. Available Aug. 1, 1933. D-2194.

Civil Engineer; Jun. Am. Soc. C.E.; 26; married; B.S., Rutgers University, 1926; M.S., Massachusetts Institute of Technology, 1933; 5 years experience with large structural company, on the detailing, estimating, and designing of bridges and buildings. Pacific Coast location preferred. D-2201.

Junior Engineer; Jun. Am. Soc. C.E.; 25; married; B.S. in C.E., Kansas University; 2 years experience on concrete and timber bridge construction; 20 months experience in appraisal engineering; member of Tau Beta Pi and Sigma Tau; rating of 86.67, U.S. Civil Service Register, Junior Engineers; capable, resourceful, dependable. Desires teaching or engineering position. Available immediately. Location immaterial. D-2206.

CIVIL ENGINEERING GRADUATE; Jun. Am. Soc. C.E.; 24; single; Union College, 1932. Good office or field man with ability for leadership. Has had varied surveying experience since graduation. Working hours, location, and salary immaterial. Available after September 1, 1933. D-2204.

RECENT GRADUATE; Student Chapter member; 24; single; graduate of University of California, 1933. Two summers experience in survey party on location work, California State Highway. Also interested in cement and concrete research. No preference as to location. Available any time. D-2205-335-A-7, San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Rutgers University, 1930; 1½ years as transitman in Essex County Highway Department; passed New Jersey State Civil Service senior draftsman examination. Desires working or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in engineering, Manhattan College, 1931; 4 months on building construction; foundations; driveways, estimating and surveying; 4 months on estate work, grading and miscellaneous small dwelling structures; desires work in any branch of civil engineering. Location immaterial. Available immediately. C-6943.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; B.S. in C.E.; single; 7 years experience in waterworks and building construction. Excellent draftsman. Available July 15. Location and salary open. D-2211.

RECENT GRADUATE IN C.E.; with some teaching experience, practical experience, and business training. Would like work in some foreign country or in Alaska. Business training includes knowledge of shorthand and typewriting. D-2210.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E.; 3 years varied experience with contractors on highway construction and on concrete structures. Available immediately. Location and salary secondary. D-2215.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.S. in C.E.; New York University, 1930; 3½ years office and assistant engineer with general contractors on Holland and East River tunnels; draftsman; estimating and computing steel, concrete, waterproofing; building inspection, electric welding, and building settlements; also hydraulic surveys, planning, and running. With contractor anywhere. D-1921.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; evening college education in C.E.; 14 years experience as surveyor; city and state licenses, New York. Quick, accurate instrumentman; 8 years in responsible charge of engineering party on large location, monumentation, construction projects, and city surveying. Desires field position. Location in vicinity of New York City. D-2216.

SALES

STRUCTURAL ENGINEER, DESIGNER, AND SALESMAN; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Last 8 years head of consulting engineering office, specializing in structural designing for architects, owners, and contractors. Large acquaintance among architects and contractors in northern New Jersey. A-5489.

TEACHING

PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; American-born; Presbyterian; Ph.B., B.S., M.S., and C.E.; open for position; 20 years engineering experience (12 with one employer); 4 years teaching major course, structural theory, and design, strength of materials, statics, kinematics, kinetics. Qualified personally. B-5954.

MATERIALS ENGINEER; Jun. Am. Soc. C.E.; 30; married; registered civil engineer; B.S.E. and M.S.E., Michigan University; 9 years in Michigan State Highway Laboratory; thorough knowledge of materials, material testing; last 3 years in charge of laboratory investigations. Possible connections; other testing organizations; material producer in laboratory or engineer representative; teaching highway subjects, especially materials. Available now. D-2196.

CIVIL ENGINEER; M. Am. Soc. C.E.; Member S.P.E.E.; married; degrees B.S., C.E., M.S.; 13 years successful teaching experience in one college; 4 years practical experience. Desires teaching position in civil engineering or applied mechanics. D-302.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1933. The statements made regarding the books are taken from the books themselves, and this Society is not responsible for them.

ELEMENTS OF POWER GENERATION. By A. M. Greene, Jr. New York, John Wiley and Sons, 1933. 314 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.25.

Intended to give the young engineering student and the general reader an appreciation of the various ways in which power is obtained from natural sources, this book describes the principles, limitations, and operation of the equipment of the modern power station.

FORSCHUNGSHEFT 359. GEBÄUDESCHWINGUNGEN. By G. Scharrer and O. Brötz. Berlin, VDI-Verlag, 1933. 24 pp., illus., diagrs., charts, tables, 12 × 8 in., paper, 5 rm.

Two studies concerned with the effects of vibration in buildings caused by traffic or machinery, and with ways of preventing them. A method is developed for predetermining the natural period of vibration of a building, which is sufficiently exact for practical purposes. The results of measurements upon floors, walls, and brick piers are given.

GENERAL PROPERTIES OF MATTER. By F. H. Newman and V. H. L. Searle. 2 ed. New York, Macmillan Company, 1933. 388 pp., diagrs., tables, 9 × 6 in., cloth, $4.

The aim of the this book is to present a fairly complete survey of the fundamental properties of matter, developing especially such branches of the subject as surface tension, osmosis, and viscosity, which are particularly important to the mathematician and engineer.

IRRIGATION PRACTICE AND ENGINEERING. VOL. 1. USE OF IRRIGATION WATER AND IRRIGATION PRACTICE. By B. A. Etcheverry and S. T. Harding. 2 ed. New York and London, McGraw-Hill Book Company, 1933. 256 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $2.50.

A presentation of the essential features of good practice in the handling and use of water on the farm. The physical properties of soils, water requirements of irrigated farms, preparation of land and methods of irrigation, farm distribution, and small pumping plants are discussed. It is a textbook for college students and those engaged in building or managing irrigation systems. This edition has been entirely rewritten.

MEHRSTIELIGE RAHMEN. Bd. 2, Liefg. 1–4. By A. Kleinlogel. 3 ed. Berlin, W. Ernst and Sohn, 1932–1933. Diagrs., tables, 10 × 7 in., paper, Lief. 1, 80 pp., 6 rm.; Lief. 2, pp. 81–160, 6 rm.; Lief. 3, pp. 161–240, 6 rm.; Lief. 4, pp. 241–291, 4.50 rm.

Professor Kleinlogel's book provides working formulas for the calculation of most types of statically indeterminate structures that are in common use. The present volume, which concludes the work, is chiefly concerned with mill buildings and multi-story buildings. Twelve major types of structures and seven special cases are considered, and two fully worked examples are given.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GHH-KONZERNS, Band 2, Heft 5, March 1933. Berlin, VDI-Verlag. pp. 99–134, illus., charts, diagrs., tables, 12 × 8 in., paper, 4 rm.

Articles on notch testing of weld steel and cupola operation in melting high-grade gray pig-iron.

MITTEILUNGEN DES HYDRAULISCHEN INSTITUTS DER TECHNISCHEN HOCHSCHULE MÜNCHEN, Heft 6. Edited by D. Thoma. Munich and Berlin, R. Oldenbourg, 1933. 60 pp., illus., diagrs., charts, tables, 11 × 8 in., paper, 4.20 rm.

Four articles, of which three deal with the Gibson method for measuring the flow of water in conduits. Of these, two describe the development of a photographic pressure recorder of greater exactitude than former ones, and one deals with the oscillations in flow disclosed by it. The fourth describes an investigation of resistance to flow at elbows in open channels.

POPULATION TRENDS IN THE UNITED STATES. By W. S. Thompson and P. K. Whelpton. New York and London, McGraw-Hill Book Company, 1933. 415 pp., diagrs., charts, tables, 10 × 6 in., cloth, $4.

In gathering information on population for the President's Research Committee on Social Trends, extensive compilations were accumulated, which could not be included in the Committee report. These longer tables are presented here and their significance discussed in greater detail.

PUBLIC UTILITY RATE STRUCTURES. By L. R. Nash. New York and London, McGraw-Hill Book Company, 1933. 379 pp., charts, tables, 9 × 6 in., cloth, $4.

A compilation of technical, as distinct from legal, information about rate practices and applications. Such topics as rate reduction, promotional rates, regulation of rates vs. regulation of profits, cost analyses, and economic factors are discussed. The distinctive features of the rate structures used by electric, gas, local transportation, communication, water, and street lighting services are also considered.

ROADMASTER AND HIS WORK. By E. E. R. Tratman. Scranton, International Textbook Company, 1932. 68 pp., diagrs., charts, tables, 8 × 5 in., leather, $1.

A concise, practical manual, describing the roadmaster's duties and methods of performing them.

STREET TRAFFIC FLOW. By H. Watson. London, Chapman and Hall, 1933. 395 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, 21 s.

An analysis of the behavior of street traffic, to determine the causes that retard its circulation and the magnitude of their effect, and to discuss means of expediting movement. Economic aspects are taken into account. The extent to which different types of vehicles affect the movement and speed of traffic is discussed, and the means by which traffic may be expedited and accidents diminished are considered.

TECHNICAL MAN SELLS HIS SERVICES. By E. Hurst. New York and London, McGraw-Hill Book Company, 1933. 239 pp., 8 × 6 in., cloth, $2.

The purpose of this book is to help the technical man find a job. The author writes from a background of extensive experience in helping college graduates find positions. A series of typical cases that illustrate the methods advocated is given.

TRANSITION ZONING. By A. C. Comey. Cambridge, Mass., Harvard University Press, 1933. 150 pp., illus., diagrs., tables, 10 × 7 in., cloth, $2.50.

The problem of regulating buildings and land use at the borders of zoning districts, where differently restricted districts meet, is discussed. The author has studied all the ordinances upon this subject now in force in the United States, arranged them in categories, and suggested model clauses for each.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

BELGIUM. Note on Some Concrete Arched Structures, R. Despretz. *Int. Ry. Congress Assn.—Bul.* (*English Edition*), vol. 15, no. 4, April 1933, pp. 358–387. Brief notes on concrete arch bridges, designed and built within recent years by the Belgian National Railway Company, in connection with the construction of new lines; Pede Viaduct; Luttre Bridge at Forest; Rue du Charroi Bridge at Forest; structures on Molenbeek and Cauterbroeckbeek; and others.

BRITISH COLUMBIA. Burrard Bridge Fine Example of Structural Engineering. *Can. Engr.*, vol. 64, no. 16, April 18, 1933, pp. 5–8 and 10. Construction, structural, and architectural features of a highway bridge in Vancouver, B.C., comprising a center span 350 ft long and carrying a 3-lane roadway 60 ft wide; cost $3,500,000.

CONCRETE ARCH, GREAT BRITAIN. Twickenham Bridge. *Civ. Eng.* (*London*), vol. 28, no. 321, March 1933, pp. 88–91. Features of the new concrete arch highway bridge at Richmond, over the Thames River, consisting of five spans up to 103 ft 4 in. in length, costing about £200,000.

CONCRETE GIRDER, CONSTRUCTION. Building Bohemia River Bridge. *Contractors and Engrs. Monthly*, vol. 26, no. 4, April 1933, pp. 13–16. Construction of a reinforced concrete highway bridge, at the head of the Chesapeake Bay, Maryland, consisting of 29 spans of 35 ft each and a double bascule span, carrying a 20-ft roadway.

CONSTRUCTION. Concrete Arch Ribs of Rogue River Bridge Decentered by Built-In Jacks, G. S. Paxon and M. Dresser. *Construction Methods*, vol. 15, no. 4, April 1933, pp. 36–39. Use of the Freyssinet method of arch decentering and stress adjustment for the first time in the United States in the construction of the Oregon Highway Bridge, comprising seven 230-ft spans.

DESIGN, EUROPE. Foreign Bridges Exemplify Unusual Designs. *Eng. News-Rec.*, vol. 110, no. 16, April 20, 1933, pp. 497–500. Compilation from foreign press articles, presenting examples of the unsymmetrical three-hinged steel arch, through-type concrete cantilever, unsymmetrical spans eliminating falsework, suspended-cantilever bridge, concrete Vierendeel truss, and the floating bridge.

FLOORS. Combining Concrete and Timber for Trestle Decks, G. D. Burr. *Eng. News-Rec.*, vol. 110, no. 17, April 27, 1933, pp. 523 and 524. Review of some early experiments with suggestions for rational economic design; load-slip for ⅝-in. spikes in shear between concrete and timber; advantages to be gained by combined use of concrete and timber in trestle decks.

HIGHWAY, DESIGN. Design of Approaches to Highway Bridges, H. Criswell. *Roads and Road Construction*, vol. 11, no. 123, March 1, 1933, pp. 72–74. Numerical example comparing four methods outlined. (Concluded.)

RIGID FRAME. Ten Years of Achievement with Rigid-Frame Bridges. *Eng. News-Rec.*, vol. 110, no. 17, April 27, 1933, pp. 531–533. Review of experience with some 200 structures from 20 to 224 ft in span, built of reinforced concrete, in addition to several of the steel-rib type with a maximum span length of 230 ft; partial list of rigid-frame bridges, principally in America.

Unusual Designs Are Used for Concrete Bridges. *Ry. Age*, vol. 94, no. 13, April 1, 1933, pp. 468–470. Structural features of several rigid-frame concrete bridges and viaducts recently constructed by the Central Kansas Division of the Missouri Pacific Railroad, in connection with a line and grade-revision project costing $6,500,000; splicing of concrete piles; use of transit mixers; new type of overhead bridge.

STEEL TRUSS, KENTUCKY. Louisville and Nashville Completes Outstanding Bridge. *Ry. Age*, vol. 94, no. 18, May 6, 1933, pp. 658–662. Construction of a steel truss railroad bridge over the Ohio River at Henderson, Ky., having a total length of 7,887 ft, and a maximum span of 675 ft; protection against corrosion; construction of 66 concrete piers, of which seven are river-span piers, with heights ranging from 104.9 to 126.6 ft; sinking the caissons; erection methods.

STRENGTHENING. Le renforcement du viaduc d'Orival, E. Fredet. *Arts and Metiers*, no. 150, March 1933, pp. 83–87. Strengthening the superstructure of the Orival railroad bridge, in France, consisting of six spans totaling 283.6 m in length.

SWEDEN. The Tranebergssund Bridge. *Concrete and Constr. Eng.*, vol. 28, no. 4, April 1933, pp. 227–237. Features of a new bridge, to replace the existing floating bridge, over the Tranebergssund in Stockholm, which will be constructed as a fixed reinforced concrete arch, with a theoretical span of 594 ft, and with adjoining viaducts of the pier and girder type; staging of arches; concreting of arches; materials, quantities, and costs.

TOLL. Survey of Toll Bridge Field, P. K. Schyler. *Roads and Streets*, vol. 87, no. 4, April 1933, p. 146. Historical notes and statistical data on toll bridges in the United States.

BUILDINGS

CONSTRUCTION. Stone Setting Contractors Use Gantry Crane to Solve Problem of Erecting Sixty-Two Gigantic Stone Columns. *Stone*, vol. 54, no. 4, April 1933, pp. 164–166. Methods of handling and setting monolithic stone columns 5 ft 3 in. in diameter and 36 ft 6 in. long, weighing about 60 tons each, in connection with the construction of the Mellon Institute Building, at Pittsburgh, Pa.

EARTHQUAKE EFFECTS. Appraisal Made of Southern California's Earthquake Damage, J. I. Ballard. *Construction Methods*, vol. 15, no. 4, April 1933, pp. 32–34. Observations on modes of failure of the various types of buildings.

HIGH BUILDINGS, WIND STRESSES. Wind Pressure on Model of Empire State Building, H. L. Dryden and G. C. Hill. *U.S. Bur. Standards—Journal Research*, vol. 10, no. 4, April 1933, pp. 493–523, 1 supp. plate. Measurements of the distribution of wind pressure over a model of the Empire State Building for the purpose of comparing results of model tests with measurements on actual building, now in progress under the direction of the Research Committee of the American Institute of Steel Construction; overturning moments measured for same wind directions; procedure for comparison of results on model with those on actual building.

OBSERVATORIES, UNITED STATES. Naval Observatory, F. Hellweg. *Military Engr.*, vol. 25, no. 141, May–June 1933, pp. 209–213. History of the U.S. Naval Observatory and a review of its activities and objectives; standard of time measurement; determination of standard time; procedure used in broadcasting standard time.

WATERPROOFING. Waterproofing of Concrete and Brickwork Structures and Buildings, A. S. Buckle. *Surveyor*, vol. 83, no. 2151, April 14, 1933, pp. 411 and 412. Waterproofers; waterproofing concrete; examples of works executed. Before Inst. Sanitary Engrs.

WRECKING. Regulations Governing Wrecking of Buildings. *Contract. Rec.*, vol. 47, no. 18, May 3, 1933, pp. 439 and 440. Wrecking specifications and safety rules adopted by the Construction Safety Association of Ontario.

CITY AND REGIONAL PLANNING

CITIES AND TOWNS. Municipal Cost Accounting, A. A. O'Shea. *Nat. Assn. Cost Accountants—Bul.*, vol. 14, no. 17, May 1, 1933, pp. 1269–1290. Contrast between the practices of private corporations and municipalities; possibilities of control through municipal cost systems; examples of record forms used in the town of Brookline, Mass.

COST ACCOUNTING. Accounting for Boroughs and Villages, W. H. Fisher. *Nat. Assn. Cost Accountants—Bul.*, vol. 14, no. 17, May 1, 1933, pp. 1291–1314. Details of a system now in operation in one of the boroughs of Pennsylvania.

CONCRETE

CEMENT SETTING. French Study Set and Hardening of Cement, E. Marcotte. *Pit and Quarry*, vol. 25, no. 7, March 1933, pp. 54 and 55. Conclusion drawn from adiabatic curves prepared by the author; area between adiabatic curve and time axis measures the future mechanical strength of cement; essential characteristic of hardening process, as distinct from set, is a rectilinear relation between the strength and logarithm of time. Previously indexed from *Génie Civil*, Jan. 28, 1933.

CONSTRUCTION. Need of Better Concrete, A. M. Bouillon. *Military Engr.*, vol. 25, no. 141, May–June 1933, pp. 259–263. Placing steel reinforcement; depositing concrete; insuring workability; mechanical vibrators; purchasing ready-mixed concrete; dangerous results of laitance; construction and expansion joints; necessity for proper curing; water curing; other methods of curing; time required for water curing; curing under winter conditions; control of internal heat; heating of concrete in winter. (To be continued.)

MIXING. Water Control in Concrete, J. S. Boissier. *Eng. Assn. Malaya—Quarterly Journal*, vol. 1, no. 1, Jan. 1933, pp. 24 and 25. Description of a simple automatic water control apparatus used in concrete construction in southeastern Asia.

PUMP PLACING. La mise en place du béton au moyen d'une pompe. *Génie Civil*, vol. 102, no. 15, April 15, 1933, pp. 352–354. Review of the European and American practice of pumping concrete; features of concrete placing in pumps.

TESTING, STRENGTH. 8-Hour Accelerated Strength Test for Field Concrete Control, O. G. Patch. *Am. Concrete Inst.—Journal*, vol. 4, nos. 7 and 8, March–April 1933, pp. 318–324. Method of testing concrete specimens in hot water unit, developed in the construction of Boulder Dam.

CONSTRUCTION INDUSTRY

COSTS. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 8, no. 7, April 10, 1933, pp. 194, 196, 198, 200, and supp. p. 30. Unit costs bid on bridges and culverts, pipeline construction, tunnel construction, street and road work, and machinery and equipment in California and Oregon.

DAMS

COFFERDAMS. Construction of Diversion Cofferdams, W. R. Nelson. *Reclamation Era*, vol. 24, no. 4, April 1933, pp. 45–47. Cofferdams for the diversion of flow of 200,000 cu ft per sec of the Colorado River at the site of Boulder Dam, are 66 and 98 ft in height, containing 800,000 cu yd of earth and rock.

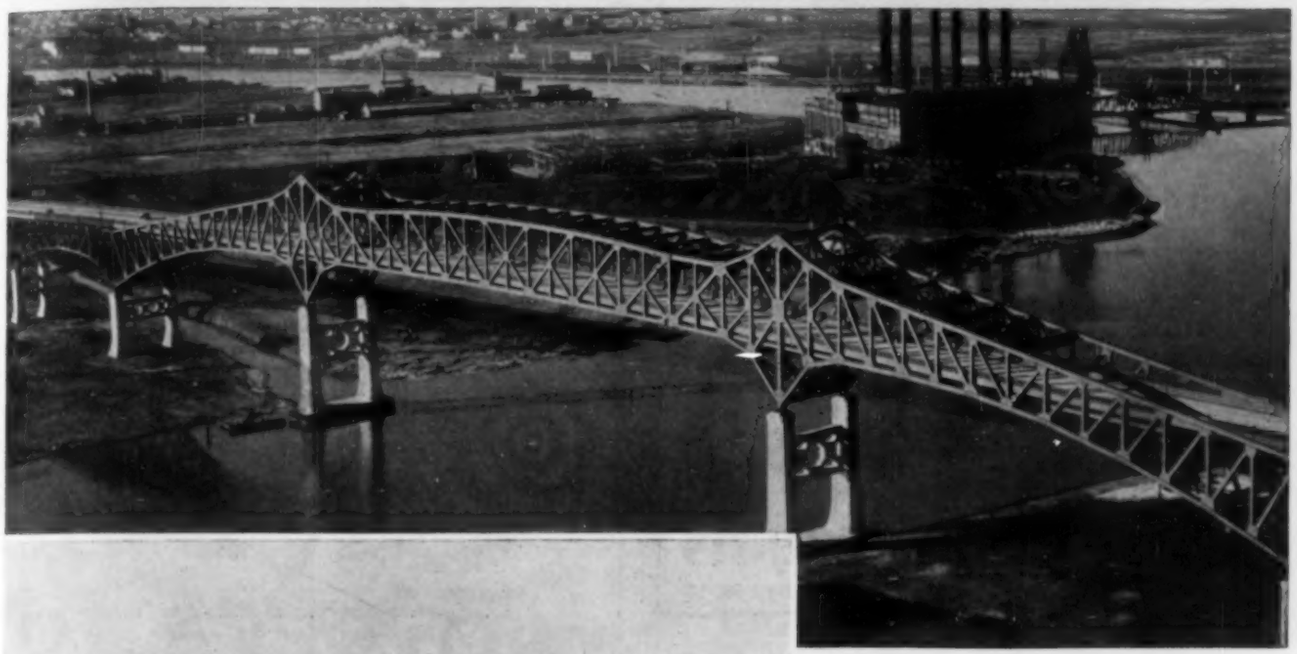
CONCRETE. Reservoir Work. *Water and Water Eng.*, vol. 35, no. 416, March 31, 1933, pp. 197–199. Review of modern British practice in the cementation, waterproofing, concrete hardening, guniting, and repairing of concrete-water distribution reservoirs.

CONCRETE, CONSTRUCTION. Vom bau der Bleilochtalsperre im Saale-Tal, R. Leonhardt. *Deutsche Bauzeitung*, no. 7, Feb. 15, 1933, pp. 126–132. Construction of Bleiloch curved concrete-gravity dam and Elbe watershed, Germany. 65 m maximum height, with special reference to methods of placing 180,000 cu m of concrete.

CONSTRUCTION. Construction of Hoover (Boulder) Dam, W. R. Nelson. *Compressed Air Mag.*, vol. 38, no. 3, March 1933, pp. 4069–4074; see also *Gen. Contractors Assn.—Bul.*, vol. 24, no. 4, April 1933, pp. 60–65. Résumé of current activities and an account of the building of cofferdams.

FAILURES. Notes on Reservoir Failures, J. M. Hogg. *Surveyor*, vol. 83, no. 2149, March 31, 1933, pp. 375 and 376. Failure of several British and American earth-fill and concrete dams; prevention of dam failures. Before Inst. Water Engrs.

TWO OF THE BRIDGES THAT WON A. I. S. C. BEAUTY AWARDS



Above: One of the two bridges, crossing the Hackensack and Passaic Rivers, which are part of the high-level highway viaduct between Newark, N. J., and Jersey City. Designed and built for the New Jersey State Highway Department under the direction of Jacob L. Bauer, state highway engineer.

Left: French King Bridge over Connecticut River, between Erving, Mass., and Gill. Designed and built for the Commonwealth of Massachusetts under the supervision of A. W. Dean, chief engineer, and G. E. Harkness, bridge engineer, Massachusetts Department of Public Works.

The members of the jury of award were Robert M. Carrere and J. K. Smith, architects; D. S. Trowbridge, C. W. Hudson, and F. E. Schmitt, engineers.

ILLUSTRATED on this page are two of the three bridges selected by the American Institute of Steel Construction as the most beautiful bridges constructed during 1932.

The award for the most beautiful structure in Class A (bridges costing over $1,000,000) went to the High-Level Highway Viaduct Bridges, crossing the Hackensack and Passaic Rivers between Newark, N. J., and Jersey City.

The French King Bridge, over the Connecticut River, between Erving, Mass., and Gill, won the Class B award for the most beautiful bridge costing between $250,000 and $1,000,000.

These prize-winning bridges were fabricated and erected by McClintic-Marshall Corporation.

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General Offices: Bethlehem, Pa. *District Offices:* New York, Boston, Philadelphia, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, San Francisco, Los Angeles. *Export Distributor*, Bethlehem Steel Export Corporation, New York

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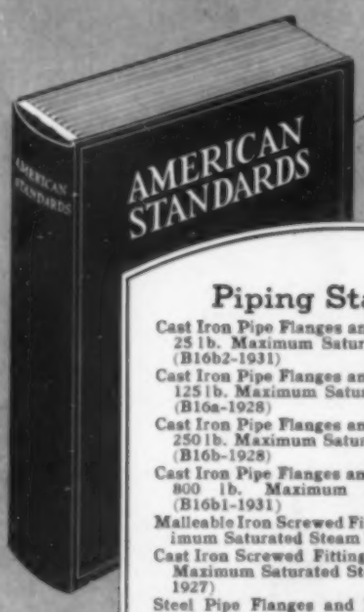

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DAM PROJECT, TUNNELS. Diversion Tunnels at Hoover (Boulder) Dam Lined with Concrete. *Construction Methods*, vol. 15, no. 4, April 1933, pp. 18–23. Four 56-ft rock bores finished with a cylindrical coating 3 ft thick, requiring 300,000 cu yd of concrete placed behind special forms; details of steel frame carriage supporting forms.

RESERVOIRS. Design and Construction of West Seattle Reservoir, S. De Moss. *Am. Water Works Assn.—Journal*, vol. 25, no. 4, April 1933, pp. 508–514. Construction of reservoir in cut and fill with sides and bottom paved with concrete slabs; designed for a capacity of 68,300,000 gal; low service tanks and pipe connections; supervision and costs.

FLOW OF FLUIDS

FLOW OF WATER, ORIFICES. Duesen und Blenden bei kleinen Reynoldsschen Zahlen, M. Hansen. *Forschung auf dem Gebiete des Ingenieurwesens*, vol. 4, no. 2, March–April 1933, pp. 64–66. Test results with different shapes of nozzles and orifices for small Reynolds' numbers demonstrate disadvantages of cylindrical portion for flow measurement.

MEASUREMENTS. Flow Measurement and Control—XXIII (Cont.), M. F. Behar. *Instruments*, vol. 6, no. 4, April 1933, pp. 77–83. Weighing meters; positive gas meters; dry types of gas meters.

FOUNDATIONS

EARTH PRESSURE. Over den zijwaartschen druk in ongeroerden, incohaerenten grond en interpretatie der "Cincinnati"-proeven no. 1 en 2, O. K. Froehlich. *Polytechnisch Weekblad*, vol. 26, nos. 44 and 45, Nov. 3, 1932, pp. 693–696, and Nov. 10, pp. 715–719. Mathematical analysis of lateral pressure in undisturbed non-cohering ground and an interpretation of the so-called "Cincinnati" earth-pressure tests.

MONUMENTS. Washington Monument Facts Brought Up to Date, D. H. Gillette. *Eng. News-Rec.*, vol. 110, no. 16, April 20, 1933, pp. 501 and 502. Borings carried to rock for the first time reveal a layer of soft clay potentially unstable under any large and unbalanced loading such as would result from proposed landscaping operations.

TESTING. Geo-hydrologisch onderzoek ten behoeve van een complex werken te Rotterdam, C. Franx. *Polytechnisch Weekblad*, vol. 27, nos. 4, 5, and 6, Jan. 26, 1933, pp. 57–59; Feb. 2, pp. 65–69; and Feb. 9, pp. 88 and 89. Study of the geology and hydrology of the foundation site for a group of buildings in Rotterdam, Holland; results of borings; computation of maximum ground-water pressure; pumping tests; analysis of results.

HYDRAULIC ENGINEERING

HYDRAULIC LABORATORIES, UNITED STATES. Current Hydraulic Laboratory Research in United States. *U.S. Bur. Standards—Report No. 1-1*, April 1, 1933, 33 pp. History of hydraulic laboratory research in the United States; descriptive notes on some 30 hydraulic laboratories; notes on some 40 research projects.

HYDRAULIC STRUCTURES, DESIGN. Experimentelle Bestimmung der Beanspruchung von Bauwerken, die einer zeitlich veraenderlichen Stroemung ausgesetzt sind, E. Meyer-Peter and H. Favre. *Schweiz Bauzeitung*, vol. 101, nos. 3 and 4, Jan. 21, 1933, pp. 29–33, and Jan. 28, pp. 48–51. Experimental study of models, made at the Hydraulic Laboratory of the Swiss Federal Institute of Technology, on stresses produced by surges and similar fluctuating flows; application of results to design of hydro-electric structures, breakwaters, walls, etc.

MODELS. Work of U.S. Waterways Experiment Station, H. D. Vogel. *Louisiana Eng. Soc.—Proc.*, vol. 18, no. 6, Dec. 1932, pp. 119–124. Historical review of the practice of hydraulic models; equipment and activities of the U.S. Waterways Experiment Station at Vicksburg, Miss.

HYDRO-ELECTRIC POWER PLANTS

GREAT BRITAIN. Severn Barrage Scheme. *Water and Water Eng.*, vol. 35, no. 417, April 20, 1933, pp. 212–214. Outline of a project for damming the Severn River estuary at English Stones, by means of a so-called sluice dam, 6,825 ft long, and by a turbine dam, 4,550 ft long, containing 72 Kaplan-type turbines with a direct coupled generator running at a constant speed of 62.5 rpm, and working under head varying from 5 to 35 ft; cost estimated at £50,500,000; maximum output 500,000 kw.

RUSSIA. Hydro-Electric Projects North of Polar Circle. *Engineering*, vol. 135, no. 3510, April 21, 1933, p. 430. In the northwest of Russia on the Kola Peninsula, rich deposits of apatite are being exploited; for processes connected with the production of aluminum, a hydro-electric power station is under construction on the Niva River with capacity for first development stage, of 60,000 kw; head between Imandra and White Sea, 425 ft, will be utilized by three stations; total ultimate capacity will be about 150,000 kw.

UNITED STATES. Hoover (Boulder) Dam Hydro Plant to House Largest Turbines. *Power*, vol. 77, no. 4, April 1933, pp. 174 and 175. Initial installation will consist of five 115,000-hp and two 55,000-hp units, plant being designed for an ultimate capacity of 1,835,000 hp in 17 units; bids for turbines were opened March 10, but contracts had not been awarded.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

EARTHQUAKES, MEASUREMENT. Measuring Earthquake Intensity in Pounds Per Square Foot, H. M. Westergaard. *Eng. News-Rec.*, vol. 110, no. 16, April 20, 1933, p. 504. Suggested deduction based on controlling maximum ground velocity for all periods in a given disturbance.

SEA WATER. Determination and Occurrence of Fluorides in Sea Water, T. G. Thompson and H. J. Taylor. *Indus. and Eng. Chem. (Analytical Edition)*, vol. 5, no. 2, March 15, 1933, pp. 86–89. Data on analysis of about 100 samples of water from various locations and depths, in the vicinity of British Columbia and the state of Washington, using zirconium nitrate-sodium alizarin sulfonate indicator for the determination of fluoride. Bibliography.

IRRIGATION

INDIA. Irrigation in India—VII and VIII. *Indian Eng.*, vol. 93, nos. 9 and 10, March 4, 1933, pp. 161 and 162, and March 10, pp. 185 and 186. Indian irrigation during World War and post-war period. (Concluded.)

SIPHONS. Bully Creek and Fairman Coules Siphons, P. Bier. *West. Construction News and Highways Bldr.*, vol. 8, no. 7, April 10, 1933, pp. 179–184. Design and construction of two steel pipe lines, 8 ft 5 in. in diameter, totaling 7,425 ft in length, on the Vale Main Canal near Hope, Ore.; by-pass and drainage features; siphon supports; inlet and outlet structures; expansion joints; pipe supports and anchors; cost data.

LAND RECLAMATION AND DRAINAGE

LAWS AND LEGISLATION. How Drainage Laws Affect Road Construction, W. G. McGeorge. *Contract. Rec.*, vol. 47, no. 15, April 12, 1933, pp. 368–371. Proper procedure to be followed by highway authorities when carrying out drainage operations; common law; statute laws; ditches and Watercourses Act; Drainage Aid Acts; Municipal Drainage Act; drainage petitions; access bridges; repairs and maintenance.

PORTS AND MARITIME STRUCTURES

BREAKWATERS. Les brise-lames a parements verticaux, J. Lira. *Génie Civil*, vol. 102, no. 14, April 8, 1933, pp. 320–325. Review of the practice of vertical wall breakwater construction in Europe and South America; analysis of stresses and types of design.

CANADA. Development of Hudson Bay Project, D. W. McLachlan. *Eng. Journal*, vol. 16, no. 4, April 1933, pp. 155–166. Development work carried out at Port Nelson from 1913 to 1917; preliminary investigations at Churchill and construction operations which followed there; particulars of docks, elevator and power house, water supply arrangements, and dredging plant; data regarding air, water, and soil temperatures; observations on ice formation as affecting length of open season at Port Churchill; cost data.

FLORIDA. Steel Pile and Concrete Breakwater Wall at Key West, Fla., B. Benson. *Contractors and Engrs. Monthly*, vol. 26, no. 4, April 1933, pp. 17–20. Driving of 4,500 steel piles in the construction of a sand-fill and concrete breakwater wall with a top width of 10 ft; driving of sheet piling and construction of form work; concrete placing.

FRANCE. Port of Havre, F. Pratt. *World Ports*, vol. 21, no. 5, March 1933, pp. 5–8 and 16. A history and description of this leading French port.

GDYNIA, POLAND. Der Seehafen von Gdingen, D. Foerster. *Werft-Reederei-Hafen*, vol. 14, no. 1, Jan. 1933, pp. 1–11. Europe's newest seaport, Gdynia, Poland; present layout; the position of Gdynia in relation to Danzig; development of the harbor; numerous illustrations of port structures, cargo-handling equipment, and railroad terminal facilities.

LIGHTHOUSES, UNITED STATES. Building and Operating the Nation's Lighthouses. *Eng. News-Rec.*, vol. 110, no. 17, April 27, 1933, pp. 517–520. Rocky Island light location; offshore lights at Chicago; modern mechanized signaling; maintenance is of major importance.

STOCKTON, CALIF. Port of Stockton Wharves and Transit Sheds, T. P. Moorehead. *West. Construction News and Highways Bldr.*, vol. 8, no. 7, April 10, 1933, pp. 173 and 174. Features of three wharves 77 ft wide with straight face from 507 to 930 ft long, and of two transit sheds each 460 ft long, with widths of 127 ft at one end and 150 ft at the other.

ROADS AND STREETS

ACCIDENT PREVENTION Saving 1,000 Lives a Year, H. A. Rowe. *Nat. Safety News*, vol. 27, no. 5, May 1933, pp. 11 and 12. Deaths in highway-railroad crossing accidents declined 40 per cent in 1932 from the peak record of 1928, meaning a saving of 1,000 lives during the year; suggestions which, if followed, would assure protection of motorist at crossing.

ASPHALT. New Type of Pavement Tried Out in Ontario, R. M. Smith. *Contract Rec.*, vol. 47, no. 17, April 26, 1933, pp. 411–414. Characteristics of the newly developed high structural strength asphalt pavement give promise of excellent service; surface is non-skid; construction procedure; tamping.

ASPHALT EMULSIONS. Evaluation of Emulsified Asphalts for Road Building Purposes, L. Kirschbraun. *Roads and Streets*, vol. 87, no. 4, April 1933, pp. 150–155. Properties of road-building emulsions; homogeneity; screening test; modified sedimentation test; correlation of sedimentation tests with storage observations; mechanical stability and "break"; McKesson, stone-mixing, and calcium-chloride tests; relation between calcium-chloride test and break upon road; quality of deposited film.

BITUMINOUS. Bituminous Paver Spreads and Finishes Coarse Aggregate Type Plant Mix, A. R. Erskine. *Roads and Streets*, vol. 76, no. 4, April 1933, pp. 137–141. Design and construction of Parts 2 and 3 of Niagara Falls-Buffalo road, 3.8 miles in length in New York State; specifications for concrete foundation; placing of bituminous macadam; description of treading-finishing machine.

BRICK. Research on Fillers for Brick Pavements, J. S. Crandell. *Roads and Streets*, vol. 87, no. 4, April 1933, pp. 158–160. Laboratory study of mastic cushion courses; penetration depth; stabilizing filler; rubber admixture; emulsions as fillers; surface film.

CONSTRUCTION. Right Equipment for the Job, H. K. Church. *Eng. News-Rec.*, vol. 110, no. 18, May 4, 1933, pp. 556–559. Record and analyses of 30 road-grading jobs in Pennsylvania, aggregating 1,400,000 yd, providing a basis for selecting economical equipment for the average and individual grading operation; excavation theory; volume and length percentage; distribution of total exacavation according to depth of cut, shown by empirical and theoretical curves.

CURVES. Sulla conformazione della superficie stradale agli estremi delle curve, L. Stabilini. *Strade*, vol. 15, no. 1, Jan. 1933, pp. 19–22. Theoretical mathematical analysis of design of transitions at extremities of road curves.

EXPANSION JOINTS. Transverse Expansion-Joint Installation Practice in Ontario Highways, M. L. Baxter and W. C. Brockway. *Can. Engr.*, vol. 64, no. 18, May 2, 1933, pp. 9 and 10. Practice of the Ontario Department of Highways; essential requirements of satisfactory expansion-joint installation.

EXPLOSIVES. Explosives for Settling Highway Fills, E. Godfrey. *Can. Engr.*, vol. 64, no. 18, May 2, 1933, pp. 11–13. Method of using explosives for displacing unstable materials beneath highway embankments to permit accelerated settlement of these embankments to hard bottom; trench blasting; underfill method; relief method.

HOOVER (BOULDER) DAM PROJECT. Hoover (Boulder) Dam Highway Nears Completion, W. H. Buntin. *Highway Mag.*, vol. 24, no. 2, Feb. 1933, pp. 31–34. Construction of an 8-mile section of oil-bound gravel highway 22-ft wide; drainage provided by corrugated culverts; cost data for culverts on Boulder Dam railroad.

ICY ROADS. Salt for Icy Roads, G. E. Gollop. *Can. Engr.*, vol. 64, no. 14, April 4, 1933, p. 16. Note on experiments conducted at the Sandwich, Ontario, plant of Canadian Industry, Ltd., demonstrating the effectiveness of fine salt mixed with sand in protecting traffic on ice-covered roads.

ITALY. L'autostrada Torino-Milano, I. Vandone. *Strade*, vol. 15, no. 1, Jan. 1933, pp. 1–7. Description of the automobile highway between Milan and Turin, about 126 km in length; features of bridge structures.

LOW COST. Stabilized Gravel Street, K. B. Robertson and D. N. Smith. *Am. City*, vol. 48, no. 5, May 1933, pp. 46–50. Description of a low cost project at Midland, Mich.; curb and catch-basin design and construction; preparing grade; studies of soil properties; mixing sand and clay; combination of materials; costs; unemployed labor used.

MACADAM. Road Builders Offer Specifications for Cement-Bound Macadam. *Concrete*, vol. 41, no. 5, May 1933, pp. 9–10. Gustafson Committee report establishes detailed construction practice for penetration type; sandwich type suited to resurfacing old gravel or macadam.

MAINTENANCE AND REPAIR. Details of Street and Highway Maintenance, B. E. Gray. *Pub. Works*, vol. 64, no. 4, April 1933, pp. 23, 24, and 28. Maintenance requirements; patching; deep depressions; pre-mix patches.

Old Highway Surfaces in Illinois Repaved with Brick. *Construction Methods*, vol. 15, no. 4, April 1933, pp. 28–30. Salvaging of some 60 miles of old concrete pavements, still of value as base courses, by resurfacing them with a wearing course of 2 1/2-in. brick laid between concrete curbs on 3/4 to 1 1/2-in. sand-mastic cushion.

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NORTH CAROLINA. Ten Years' Experience with Sand-Asphalt Roads in North Carolina. *Construction Methods*, vol. 15, no. 4, April 1933, pp. 24 and 25. Review of the experience of the North Carolina State Highway Commission in laying more than 1,000 miles of sand-asphalt surfacing.

ONTARIO. Ontario's Investment in Roads. R. M. Smith. *Can. Engr.*, vol. 64, no. 18, May 2, 1933, pp. 15 and 16. Statistical data on mileage costs and revenues.

RAILROAD CROSSINGS. What Kind of Grade Crossing? *Ry. Eng. and Maintenance*, vol. 29, no. 5, May 1933, pp. 226–233. Experience of railroad engineers with existing grade crossing designs and a search for a satisfactory form of construction; the best form available should be used on the busiest crossings and the less expensive applied to secondary crossings.

ROCKY COUNTRY. Wagon Drills Prove Good Roadbuilders. C. H. Vivian. *Compressed Air Mag.*, vol. 38, no. 3, March 1933, pp. 4079–4083. Use of Ingersol-Rand wagon drills for blast-hole drilling in the construction of highways in the rocky country of West Virginia.

SIGNALS AND SIGNALING. Primary Battery Floating on Storage for Operation of Crossing Signals. *Ry. Signaling*, vol. 26, no. 4, April 1933, p. 89. Missouri Pacific recently installed flashing-light highway crossing signals at Huggs crossing on a single-track line near Crystal City, Mo.; crossing is not in automatic block signal territory and is remote from any commercial current supply; primary battery for track circuits and for operation of flashing-light crossing signals.

SWAMPS. Boring and Sounding Equipment Used in Accelerating Swamp Fill Subsidence. W. Schultz. *Explosives Engr.*, vol. 11, no. 4, April 1933, pp. 109–113. Equipment and methods used in exploration, by the Minnesota Highway Department, for subsidence blasting in the construction of a highway across a peat swamp; resistance or penetration hammer; details of jack used for pulling sounding rod used with resistance hammer.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Operation of Activated Sludge Plants Practically Considered. R. J. Spode. *Surveyor*, vol. 83, no. 2150, April 7, 1933, pp. 391–393 (discussion) 393–395. Mixing during aeration period; preservation of aerobic conditions; control of activated sludge plants; reactivation of sludge; disposal of activated sludge; sludge digestion; use of lagoons; sludge drying experiment; maintenance of machinery connected to plant; graphical record of plant performance. Before Inst. Sewage Purification.

ASSESSMENT. Progress on Sewer-Rental Legislation. *West. Construction News and Highways Bldr.*, vol. 8, no. 7, April 10, 1933, pp. 185 and 186. Recent legislation in Oregon, Montana, Idaho, California, Colorado, Utah, and Washington.

EDINBURGH, SCOTLAND. Recent Main Drainage and Other Sewerage Works in Edinburgh. L. Carnie. *Surveyor*, vol. 83, no. 2153, April 28, 1933, pp. 453–456. Description of extension undertaken during past five years, including a circular sewer tunnel, 60 ft in diameter, screening plants, etc.; cost data; total cost £367,250. Before Inst. Mun. and County Engrs.

EQUIPMENT. Mechanical Equipment in Sewage Treatment Works—XI. A. P. Folwell. *Pub. Works*, vol. 64, no. 4, April 1933, pp. 41, 42, and 44. General construction and operating equipment; valves and gates; weirs and meters; conveyors; collecting samples.

FINANCING. Fact and Fancy in Sewerage Financing. A. Wolman. *Sewage Works Journal*, vol. 5, no. 2, March 1933, pp. 302–308. Basic principles of financing sewerage systems; deviations of basic principles; sectional prejudices; accounting expense; control by local interested groups. Bibliography. Before New York State Sewage Works Assn.

GREAT BRITAIN. Storm-Water Pumping. *Power Engr.*, vol. 28, no. 325, April 1933, pp. 141–144. Description of and operating experience with 800-hp oil-engine sewage pumping plant, employed by the Borough of Acton for storm-water raising.

HEATING. Heating Top Sludge. H. W. Taylor. *Pub. Works*, vol. 64, no. 4, April 1933, pp. 16–18. Seasonal sludge digestion; partial operating data of sewage works at Saranac Lake, N.Y.; causes of variations; results of experiments.

INDIA. Bhatpara Sewage Pumping Station. *Indian Eng.*, vol. 93, no. 11, March 18, 1933, pp. 212–214. Description of plant equipped with two 7-in. and three 10-in. sewage pumps.

NEW JERSEY. Meeting of New Jersey Sewage Works Association. *Water Works and Sewerage*, vol. 80, no. 4, April 1933, pp. 129–134. Proceedings including abstracts of the following papers: Chemical Treatment of Sewage in Connection with Operation of Sprinkling Filters, J. R. Downes; Operation of New Sewage Treatment Plant at Princeton, N.J., I. R. Riker; Operation of Freehold Plant, W. J. Schiverea; Comparison of Treatment of Fresh and Stale Sewages, W. Rudolfs; Developments in Sewage Chlorination, A. E. Griffin; Operating Data on Sprinkling Filters, I. O. Lacy; Pollution of Bathing Water and Its Effect on Health, C. G. Wigley; Application of Sewer Rental Law in New Jersey, C. A. MacDonald; New Rules Covering Licensing of Sewage Plant Operators in New Jersey, J. B. Baty.

ONTARIO. Trends in Sewage Treatment. A. C. Berry. *Contract Rec.*, vol. 47, no. 16, April 19, 1933, pp. 395–400. Use of mechanical equipment continues to expand, and biological methods of control are being replaced by mechanical processes; list of sewage treatment plants in Ontario showing type and special features.

SAN ANTONIO. Sludge Drying Beds, San Antonio Sewage Treatment Plant. W. S. Stanley. *Water Works and Sewerage*, vol. 80, no. 4, April 1933, pp. 123 and 124. Design and operation of a sludge drying plant occupying an area of 84,000 sq ft; construction and operating costs.

SEDIMENTATION. Factors Affecting Efficiency of Sewage Sedimentation. G. J. Schroepfer. *Sewage Works Journal*, vol. 5, no. 2, March 1933, pp. 209–232. Raw sewage sedimentation; physical characteristics of design; detention period; velocity of flow; depth and ratio of length to depth; inlet and outlet effects; shape of tank; baffling; mechanism effects; currents caused by wind, eddies, and difference in temperature; bottom reaction; electrical and biological effects. Bibliography.

SEWAGE TANKS, FOAMING. Chlorination Controls Foaming Imhoff Tanks. F. West. *Water Works and Sewerage*, vol. 80, no. 4, April 1933, p. 137. Effects of prechlorination on foaming Imhoff tanks, Stockton, Calif.

SEWERS, GASES. Generation of Hydrogen Sulfide in Sanitary Sewers. F. D. Bowlus and A. P. Banta. *Water Works and Sewerage*, vol. 80, no. 4, April 1933, pp. 141–143. Effect of temperatures on septicity and sulfide determination; effect of velocity on H_2S generation; effect of sulfate content on H_2S generation; effect of sewage strength on H_2S generation; relation between chlorine demand and biological oxygen demand.

SLUDGE POWER GAS from Sewage Sludge. F. C. Vokes. *World Power*, vol. 19, no. 112, April 1933, pp. 210–214. Old and modern methods used in the treatment of sewage; treatment of sludge by a separate digestion process evolved at Birmingham 20 years ago; gas collection method and gas utilization of Birmingham Tame and Rea District Drainage Board's different works described; gas engines driving generating machinery supply current for pumping machinery, air compressors, lighting, etc., both at Saltley and Yardley works.

STREAM POLLUTION. Studies of Effect of Small Impounding Reservoir on Stream Purification. G. M. Ridenour. *Sewage Works Journal*, vol. 5, no. 2, March 1933, pp. 319–332. Data on small stream, receiving heavily polluted load of domestic sewage, upon which a small impounding reservoir is located; biochemical oxygen demand reduction; dissolved oxygen furnished by pond; reduction in B. coli; re-aeration and deoxygenation coefficients of pond; calculated benefits of natural storage on stream purification. Bibliography.

VIRGINIA. Proceedings of the Fourth Annual Conference of the Virginia Water and Sewage Works Association, Held at Staunton, Virginia. *Va. Polytechnic Inst.—Bul.*, no. 29, vol. 26, no. 6, April 1933, 39 pp. Includes the following papers: Water Supply of Staunton, R. H. Catlett; Location of Service Reservoir and Design of Pipe Systems for Best Distribution of Water, B. S. Parrish; Pumping Equipment and Use of Automatic Stokers, R. H. Herbert; Maintenance of Water Meters, C. W. Davis; Use of Ammonia-Chlorine in Richmond, M. C. Smith; New Sewage System and Disposal Plant at Orange, W. C. Ansell; Sewage Treatment Plant at Winchester, P. P. Pilcher; Discussion of Sewage Treatment, F. J. Sette; Operation of Moore's Creek Sewage Disposal Plant, S. Williamson; Methods of Well Construction, C. F. Cole; Success in Obtaining Water from Drilled Wells in Virginia, G. Sydnor; Municipal Water Supplies of Virginia, F. H. Fish; Industrial Utility of Surface Waters of Virginia, W. D. Collins; Notes on Geology of Virginia, A. Bevan.

STRUCTURAL ENGINEERING

ARCHES, DESIGN. Determining Camber Allowances for Two-Hinged Arches. B. G. R. Holloway. *Structural Engr.*, vol. 11 (New Series), no. 3, March 1933, pp. 152–155 and (discussion), vol. 11 (New Series), no. 4, April 1933, p. 200. Demonstration of principles and processes applicable to the determination of camber for two-hinged spandrel-brace steel arches, particularly bridge arches.

COLUMNS, BENDING. Quelques mots sur la flexion des colonnes à moments d'inertie variables. L. LeMaire. *Revue Universelle des Mines*, vol. 76, no. 5, March 1, 1933, pp. 132 and 133. Contribution to the study of the deflection of columns at variable moments of inertia; presentation of formulas developed by the author in the course of an investigation of stability.

STRESSES. Direct and Bending Stresses in Cylindrical and Conical Thin Walls. C. M. Moir. *Roy. Tech. College—Journal*, vol. 3, part 1, Jan. 1933, pp. 137–162. Discussion is restricted to symmetrical loading effects, both axial and lateral; cyclical and varying loads are not included; illustrations of method of application of derived equations.

STRUCTURES, EARTHQUAKE EFFECT. Earthquakes and Engineering Structures. *Engineering*, vol. 135, no. 3511, April 28, 1933, p. 478. Review of three papers before the Institution of Civil Engineers, as follows: Influence of Earthquakes on Structural Design, H. C. E. Cherry; Effect of Earthquakes on Engineering Structures, F. W. Furkert; Design of Earthquake-Resisting Structure; Dominion Museum, Wellington, N.Z., J. J. Booth.

TUNNELS

WATER SUPPLY, CONCRETE LINING. Guniting with Lumnite Cement. A. R. Chadwick. *Can. Engr.*, vol. 64, no. 16, April 18, 1933, p. 11. Sealing temperature cracks in the concrete lining of the water intake tunnel at Buckingham Junction, Que.

WATER SUPPLY, GATES. Steel Gates for Diversion Tunnels. W. R. Nelson. *Reclamation Era*, vol. 24, no. 3, March 1933, pp. 34–37. Purpose of gates; Stoney and bulkhead gates; closure of bulkhead gates; general installation assembly of Boulder Dam 50 by 50 bulkhead gates and of 50 by 35 Stoney gates; weights and costs.

WATER PUMPING PLANTS

AUTOMATIC. Automatic and Remote Control for Electric Pumping Stations. R. C. Allen. *Am. Water Works Assn.—Journal*, vol. 25, no. 4, April 1933, pp. 529–543 (discussion) 543–545. Reduction in the cost of pumping water by modern control equipment; starters; types of control; Baltimore Guilford Station; Erie Station; examples of supervisory control; pipe line pumping stations; Visicode system; enclosed primary switching structures; outdoor stations.

SWITZERLAND. Ein eigenartiges Grundwasser-Pumpwerk. M. Wegenstein. *Schweiz Bauzeitung*, vol. 101, no. 2, Jan. 14, 1933, pp. 22 and 23. Design of small pumping plant near Zurich, Switzerland; well water level is above inlet to storage reservoir, but pumping is necessary because the existing 100-mm pipe line is made to carry an excessive flow of 750 liters per minute.

WATER TREATMENT

AMMONIA-CHLORINE. Experience with Ammonia-Chlorine Treatment of East Providence (Rhode Island) Water Supply. J. V. Turner and C. L. Pool. *New England Water Works Assn.—Journal*, vol. 47, no. 1, Jan. 1933, pp. 13–21. Review of 18 months of experience with chloramine treatment.

CHLORINATION, CANADA. Chlorine—What It Has Done for Sanitation and Industry in Canada. N. J. Howard. *Contract Rec.*, vol. 47, no. 12, March 22, 1933, pp. 297–300. Use of liquid chlorine; chlorine machines; electrolytic process; action of chlorine; extension of use of chlorine; reduction of typhoid fever; solenoid-operated chlorine shut-off valve.

FILTRATION PLANTS, CHINA. Modern Filter Plant in China Built by Coolie Labor. E. H. Aldrich. *Eng. News-Rec.*, vol. 110, no. 16, April 20, 1933, pp. 490 and 491. Lingnan University builds 1-mgd water-purification plant on which all the construction work was done by hand labor; elevated steel tank erected by use of bamboo scaffolding.

GREECE. Operating Conditions at Athens, Greece, Water Purification Plant. L. A. Geupel. *Water Works and Sewerage*, vol. 80, no. 4, April 1933, pp. 113–116. Description of recently completed filtration and purification plant with American equipment having a capacity of 18 mgd; operating procedure; aeration; chemical feed, mixing, and prechlorination; sedimentation basins; filters and appurtenances; laboratory control; waste water recovery plant.

SOFTENING. Savings to Water Works and Consumer Through Municipal Water Softening. E. L. Lium. *Water Works Eng.*, vol. 86, no. 7, April 5, 1933, pp. 277–280. Examples in the reduction of soap consumption; reactions of consumers on using soft water; method employed in treatment plant; dosage; cost of pumpage and chemicals; savings and other factors of advantage to water works.

WELLS. Explains Analysis and Control of Water Supply at Baytown Refinery of Humble Company. P. A. Washer. *Oil and Gas Journal*, vol. 31, no. 45, March 30, 1933, pp. 84–88. Development of a well water supply low in mineral content and of satisfactory temperature for cooling needs, at the Baytown Refinery of the Humble Oil and Refining Company, at Baytown, Texas; description of wells; calculation of inflow; balancing of water utilization with extraction by systematic procedure; benefits of distributing pull on water wells; interference; sanding data; water-well analyses.

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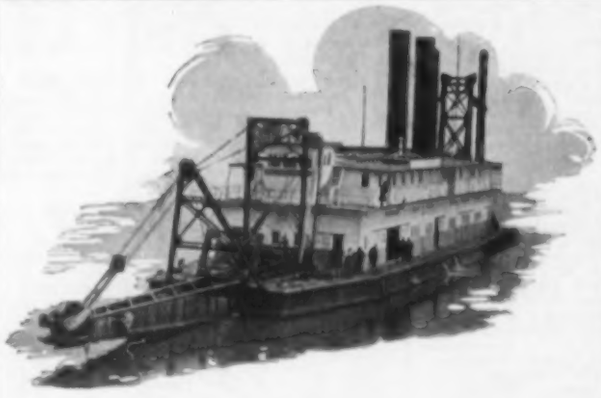

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